Asian Journal of Advanced Research and Reports

Volume 18, Issue 12, Page 405-411, 2024; Article no.AJARR.127200
ISSN: 2582-3248

Physicochemical Properties of Soils from Dumpsite in the Federal University of Technology, Owerri, Nigeria

Evangelina Ozoemena Ohaeri [a*], Callitus Iheme [a], Linus Nwaogu [a] and Emmanuel Onweremadu [b]

[a] Department of Biochemistry, School of Biological Sciences, Federal University of Technology, Owerri (FUTO), Imo State, Nigeria.
[b] Department of Soil Science, School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri (FUTO), Imo State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ajarr/2024/v18i12837

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/127200

Original Research Article

Received: 30/09/2024
Accepted: 01/12/2024
Published: 18/12/2024

ABSTRACT

Aim: To assess the physiochemical properties of Dumpsites soils from Federal University of Technology Owerri (FUTO).
Study Design: This was a simple randomized sampling study technique.
Methodology: Soil samples were obtained from three different dumpsites located within the school namely Girls' hostel dumpsite, Ihiagwa dumpsite and Eziobodo dumpsite. The soil's physicochemical characteristics were ascertained by air drying it and then sieving it through a 2 mm

**Corresponding author: Email: ohaeri@futo.edu.ng, evangelina.ohaeri@futo.edu.ng;*

Cite as: *Ohaeri, Evangelina Ozoemena, Callitus Iheme, Linus Nwaogu, and Emmanuel Onweremadu. 2024. "Physicochemical Properties of Soils from Dumpsite in the Federal University of Technology, Owerri, Nigeria". Asian Journal of Advanced Research and Reports 18 (12):405-11. https://doi.org/10.9734/ajarr/2024/v18i12837.*

sieve. The Bouyoucos hydrometer method was used to determine the soil's texture. A pH meter was used to measure the pH of a 1:2.5 soil-water suspension, and a conductivity meter was used to measure the extract electrical conductivity (EC), organic carbon using the wet digestion method of Walkley and Black. Available phosphorus by Bray and Kurtz method; total nitrogen by micro Kjeldahl procedure, as explained by Horneck and Miller (20). Following extraction with ammonium acetate, exchangeable bases were identified. Potassium (K) was measured using a flamephotometer, while calcium (Ca) and magnesium (Mg) were assessed using the EDTA titration method.

Results: Results obtained from the study, revealed that values between waste dumpsite and control site were significantly different. Findings showed that the pH value in sampled soils from studied dumpsites ranged from 6.38±0.10 and 7.11±0.10 while the mean pH value for controlled site was 3.98±0.08. Data obtained show that the values of pH; Cation Exchange Capacity (cmol+kgG1); Calcium (mEq/ 100 g);4.50; 4.24; 4.76, Potassium (mEq/ 100 g) 0.59; 0.48; 0.79 and Nitrogen (mEq/ 100 g) were. 0.98; 1.84; 0.73 respectively among the sampled dumpsites. Furthermore; Results showed that there was an increase in the pH, potassium, nitrogen content value at each dumpsite than their corresponding control. The mean soil porosity indicated higher porosity in the control sites. The soil particle size distribution indicated that the control site is sandier than the various dumpsites and the dumpsites on the other hand had more slit and clay component than the control site.

Conclusion: According to the study, trash from the dumpsite under investigation may have an impact on the distribution of grain sizes or the soils beneath them. It also showed a significant contribution to elevated pH, EC, OC, OM, Av. P, ON, basic cations, and CEC values. The soil at the study site has a higher proportion of sand fraction and a lower percentage of clay fraction, as evidenced by the relative increase in the pollutant leaching potentials of municipal solid waste.

Keywords: Soil properties; dumpsite; texture; soil nutrients; waste.

1. INTRODUCTION

The effects of industrialization, globalization, and climate change expose soils to pollution (Tamboli & Nene, 2013). Heavy metal contamination of the environment is a result of fast urbanization and industrialization, and the rates at which these metals are transferred through soil, water, and air have been steadily rising up to this point (Ali et al., 2019). High pollutant concentrations in the soil can have an impact on the microorganisms that live there (Salam et al., 2018). A significant part of agricultural food production, soil can act as both a source and a sink for harmful pollutants (Sarkar et al., 2021). Solid waste management is one of the biggest issues Nigeria is currently facing (Adewuyi & Opasina, 2010).

Regularly, municipal solid garbage is dumped on unrestricted areas, water bodies, sewers, and roadways. One of the municipal solid wastes (MSW) that has a monetary value in Nigeria is metal scrap (Ejiogu et al., 2019). All types of scraps from abandoned cars, machinery, and electrical gadgets are disassembled in the haphazardly located scrapyards in Nigerian cities and rural areas (Chikaodili et al., 2019). Heavy metals, polycyclic aromatic hydrocarbons, and other harmful elements that negatively impact the ecology are present in many of these trash items (Justin et al., 2018). These harmful compounds can be inhaled, consumed, or come into touch with the skin (Odika et al., 2020). Through their interactions with soil constituents, heavy metals found in solid municipal wastes bioaccumulate and persist in the soil, where they subsequently enter the food chain and are ingested by humans (Ogoko, 2017). Anthropogenic activities like the release of household and industrial waste, mining, smelting, and vehicle emissions are the main causes of the elevated levels of metals that build up in the soil and have an impact on surrounding ecosystems (Arukwe et al., 2012). Another well-known cause of heavy metal contamination in soils is weathering of natural rock. However, compared to natural sources, human sources contribute more metals to soils (Abasi et al., 2015). The production of scrap metal, plastic, rubber, and other consumer goods, as well as the burning of waste that contains these elements, all contribute to the release of heavy metals into the environment. When burning, the metals volatilize and are discharged into the atmosphere, depending on their density, these volatilized metals become mobile and can travel great distances to deposit on soil, vegetation, and water (Abul, 2010). Because the deposited metals are permanent and non-biodegradable, they can seriously poison people through their skin, food, or breathing. Acute exposure to these harmful metals causes rashes, gastrointestinal disorders, nausea, anorexia, vomiting, and several deaths. Because the environment serves as a direct container for waste products produced within it, heavy metal poisoning of the ecosystem is a significant social issue (Ahukaemere, 2012). In the meanwhile, both humans and animals require zinc and copper for metabolic processes (Hosea et al., 2023; Nta et al., 2020; Omeiza et al., 2022). The soils found in urban waste dumps are sufficiently rich in organic matter to be suitable for surface feeder plants (Amadi et al., 2020). According to reports, open dump sites serve the dual purposes of safely disposing of trash and concurrently enhancing the chemical characteristics of the soils that make up fruitful agricultural fields (Abul, 2010). Nigeria's waste management strategy is relatively subpar (Angaye & Abowei, 2017). Indiscriminate waste dumps and scrap dumpsites occupy almost every vacant plot of land especially along major roads and streets. This presents study aims to analyse the physiochemical properties of dumpsites around Federal University of Technology, Owerri (FUTO), Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The present study was carried out at Federal University of Technology Owerri (FUTO). The Map of the study area has been depicted in Fig. 1.

2.2 Collection of Soil Sample

The Federal University of Technology Owerri (FUTO) is a federal government university in Owerri West, Owerri, the capital of Imo State, Nigeria. The university is bounded by the communities of Eziobodo, Ihiagwa, Obinze, Okolochi and Emeabiam. It is the premier Federal University of Technology in the South-East and South-South parts of Nigeria.

= Sample titre value

= Blank titre value.

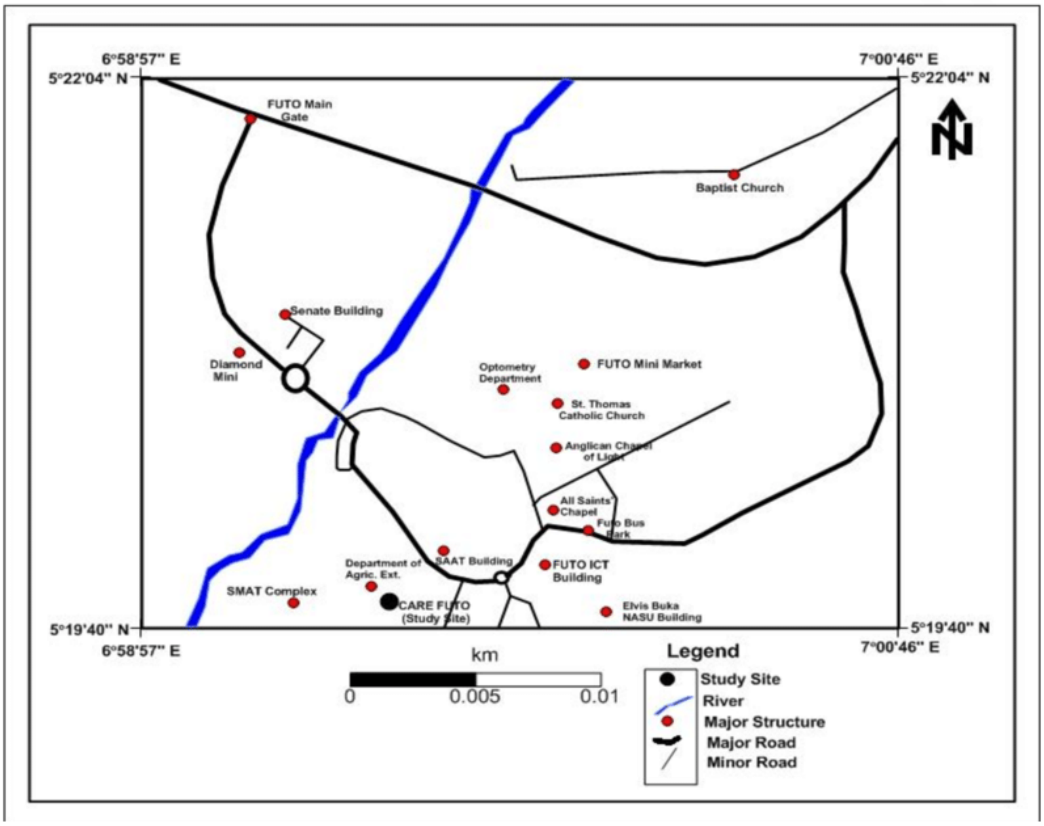

Fig. 1. Map of Federal University of Technology Owerri (FUTO)

The university is the oldest University of technology in Nigeria and was established in 1980 by executive fiat with the composition and appointment of the first provisional council by Nigeria's first Executive President, Shehu Shagari. It became the first of three such universities set up by the Federal Government of Nigeria which sought to establish a University of Technology in each geo-political region, particularly in a state which did not have a conventional university.

The dumpsite is an open dumpsite situated in Federal University of Technology Owerri (FUTO) and consisted of disposed papers, bottles, food remnants, plastics, tin cans, grasses, polyethene bags, leathers and some other biodegradables.

2.3 Collection of Soil Sample

Soil samples were obtained from three different dumpsites located within the school namely Girls' hostel dumpsite, Ihiagwa dumpsite and Eziobodo dumpsite. Samples were collected under the refuse pile at 0-15cm soil depth, using an auger borer. 15g of soil was collected. The soil was transferred into a sterile zip bag and taken to the laboratory for analysis of soil physiochemical properties.

2.4 Analysis of Soil Physiochemical Properties

The soil was air dried and sieved through a 2 mm sieve used for the determination of the physicochemical properties of the soil. The texture of the soil was determined by the Bouyoucos hydrometer method (Bouyoucos, 1962). pH by using 1:2.5 soil-water suspension and determined with a pH meter, electrical conductivity (EC) was determined on the extract for the pH using a conductivity meter, organic carbon by wet oxidation method, Walkley and Black (1934). Total nitrogen by micro Kjeldahl procedure, as described by Horneck and Miller (20) available phosphorus by Bray and Kurtz method. Exchangeable bases were determined after extraction with ammonium acetate. Calcium (Ca) and Magnesium (Mg) were determined by EDTA titration method, while potassium (K) was by flame photometer at the Soil Science Laboratory, Federal University of Technology Owerri (FUTO).

3. RESULTS

3.1 Soil Physicochemical

The physical and chemical characteristics of the studied sites were presented in Table 1. Soil *pH* ranges from 6.38-7.11 which is neutral with low EC indicating no salinity problem. The soils had low %OC which ranges from 0.44- 0.50 %. The N, P, K and CEC were higher in girls' hostel and Eziobodo dump sites.

4. DISCUSSION

A collection of quantifiable characteristics known as indicators can be used to track the condition of soil. These indicators can be broadly classified as chemical and physical indicators, and changes in these indicators can be used to measure the overall quality of the soil (Chudzicka-Czupała et al., 2023). Several physicochemical characteristics of the waste dump soil were assessed in this investigation. The three dumpsites examined for this study yielded the following pH results: Umuchima 7.11, Eziobodo dumpsite 7.08, and Girls Hostel 6.97. This is greater than the (Obianefo et al., 2017) (4.8-7.66).

pH is a number between 1 and 14, with a *pH* of 1-6.9 being considered acidic, a *pH* of 7.1 to 14 being alkaline, and a pH of 7 being neutral. These were determined to be advantageous since water with a pH of 4.0 to 4.5 has been shown to be harmful to human health.

A number of variables pertaining to the breakdown and interaction of waste products with the environment may be responsible for the higher pH values found in the dumpsite soils. Paper goods, yard debris, and food scraps are examples of organic waste items that break down over time. The production of organic acids during this process may initially cause the waste's pH to drop. The soils used in this investigation have relative electrical conductivities of 0.40, 0.43, and 0.63. The existence of ions in the soil at the dumpsite could be the cause of this outcome. The dumpsite's handling of metallic debris may also be to blame. Nonetheless, this shows that charge particles are moving, which is a positive sign for plant growth (Agbeshie et al., 2020).

Table 1. Physical and chemical characteristics of soil from experimental sites at 0-15 cm depth

Soil/Dumpsite location	Girls Hostel Dump site	Eziobodo Dump site	Umuchima Dump site	Control
pH (1:2.5)	6.81± 0.10	6.38±0.10	7.11±0.10	3.98 ±0.08
EC (dS mG1)	0.40±0.02	0.43±0.00	0.63±0.01	0.18. ±0.02
OC (%)	0.44± 0.03	0.48± 0.00	0.50± 0.01	0.20 ± 0.03
Texture				
Sandy	62.5± 0.1	65.8± 0.02	68.3± 0.1	84.32 ± 0.13
Clay	15.8± 0.02	16.2± 0.05	15.4± 0.03	11.50 ± 0.05
Slit	21.7± 0.10	18± 0.02	16.3± 0.08	1.24 ± 0.10
N (mEq/ 100 g)	0.98 ± 0.00	1.84 ± 0.00	0.73 ± 0.00	0.03 ± 0.00
K (mEq/ 100 g)	0.59± 0.03	0.48± 0.01	0.79± 0.03	0.02 ± 0.01
Ca (mEq/ 100 g)	4.50 ± 0.08	4.24± 0.22	4.76 ± 0.00	1.29 ± 0.10
Mg (mEq/ 100g)	1.45±0.00	0.22±0.10	2.91±0.10	0.30 ±0.09
CEC (cmol+kgG1)	13.19±0.00	11.22±0.03	13.32±0.01	20.15±0.03

EC: Electrical conductivity, OC: Organic carbon, N: Nitrogen, P: Phosphorus, K: Potassium, Ca: Calcium, Mg: Magnesium and CEC: Cation exchange capacity

In contrast to studies by Badmus et al. (2014), the percentage of organic carbon (O.C.), or the carbon conserved in organic matter, ranged between 0.44 and 0.50%. Burning solid waste on the landfill may be the cause of the % O.C. values seen in the garbage dump. The Umuchima and Eziobodo dumpsites have the highest and lowest cation exchange capacities (CECs), respectively, with CECs ranging from 11.22 to 13.32. These results are comparable to Chukwulobe & Saeed (2014) findings. These CEC results can be categorized as low, per LancropLaboratori (2013). Cation exchange capacity (CEC) is the quantity of exchangeable cations per unit mass of dry soil, which is a key factor in soil fertility. A low CEC value suggests that the soil can't keep cations in exchangeable form, which may be related to the soil's low clay concentration. Because of this, metal ion retention is minimal in every dump site that is being examined. This would suggest that the health of people and other animals that consume the water is at risk due to the high rates of heavy metals from the soils beneath the rubbish seeping into underground water.

The ladies hostel waste dumpsite had the highest phosphorus content, indicating that its impact on soil phosphorus levels was the most noticeable. On the other hand, the Umuchima waste dumpsite's phosphorus concentration was discovered, suggests a relatively smaller influence on soil phosphorus in comparison to the other dumpsites. The large amount of phosphorus discovered may be connected to the trash's nutritional value, since household and agricultural waste comprise the majority of municipal waste. The girls hostel waste dumpsite has the greatest soil potassium levels, followed by Umuchima and Eziobodo. Indeed, a number of factors, such as the type and amount of waste released at the sites and the sources of the garbage, could be responsible for the variance in potassium concentration at waste dumpsites.

The study's disposal locations had nitrogen contents ranging from 0.7±0.00 to 1.84±0.00. Compared to the control, which was measured at 0.03 ± 0.00, the nitrogen level in the different disposal sites is higher. This outcome is consistent with the research conducted by Eyankware et al. (2015). The results of this study were also supported by Wunzani et al. (2020), who observed that the soil at the dumpsite had a greater nitrogen concentration than the control. Table 1 of the study's results showed that the physicochemical characteristics of the soil component were higher in the dumpsite soil than in the controlled site. The results obtained in the study were in accordance with the results of Ogala et al. (2020) which stated that solid wastes in dumpsites had a significant increase in most of the analyzed soil properties. This increase in concentration might be as a result of the decayed and mineral content of decomposable solid waste in dumpsite.

5. CONCLUSION

According to the study, the soils from the investigated dumpsites exhibited higher values of physical and chemical characteristics than the soils from the controlled location. According to the study, garbage from the dumpsite under investigation may have an impact on the distribution of grain sizes in the soils beneath them. It also dramatically raised the values of physiochemical characteristics. The soil at the study site has a higher proportion of sand fraction and a lower percentage of clay fraction, as evidenced by the relative increase in the pollutant leaching potentials of municipal solid waste. The study's overall findings indicate that the elevated proportion of sand fraction and low clay fraction near the dumpsites may expose the underlying soils to toxic contaminants made from solid waste.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

ACKNOWLEDGEMENTS

The authors appreciate the ethics committee of Federal University of Technology Owerri (FUTO). We are also grateful to the HOD and staff of Biochemistry, Science Laboratory Technology and Soil science department of Federal University of Technology Owerri (FUTO) for facilitating this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Abasi, O. I., Esom, N. E., Ezekiel, I. O., & Philip, O. N. (2015). Evaluation of pollution status of heavy metals in the groundwater system around open dumpsites in Abakaliki urban, Southeastern Nigeria. *African Journal of Environmental Science and Technology*, *9*(7), 600–609.

Abul, S. (2010). Environmental and health impact of solid waste disposal at Mangwaneni dumpsite in Manzini: Swaziland. *Journal of Sustainable Development in Africa*, *12*(7), 64–78.

Adewuyi, G. O., & Opasina, M. A. (2010). Physicochemical and heavy metals assessments of leachates from the Aperin abandoned dumpsite in Ibadan City, Nigeria. *Journal of Chemistry*, *7*(4), 1278–1283.

Agbeshie, A. A., Adjei, R., Anokye, J., & Banunle, A. (2020). Municipal waste dumpsite: Impact on soil properties and heavy metal concentrations, Sunyani, Ghana. *Scientific African*, *8*, e00390.

Ahukaemere, C. (2012). Vertical distribution of organic matter in relation to land use types in soils of similar geological history of Central Southeastern Nigeria. *Nigerian Journal of Soil and Arid Ecosystem: Re5, I*, *7*, 75.

Ali, H., Khan, E., & Ilahi, I. (2019). Environmental chemistry and ecotoxicology of hazardous heavy metals: Environmental persistence, toxicity, and bioaccumulation. *Journal of Chemistry*, *2019*(1), 6730305.

Amadi, A. N., Olasehinde, P. I., Okosun, E. A., Okoye, N., Okunlola, I. A., & Alkali, Y. B. (2020). A comparative study on the impact of Avu and Ihie dumpsites on soil quality in Southeastern Nigeria.

Angaye, T. C., & Abowei, J. F. (2017). Review on the environmental impacts of municipal solid waste in Nigeria: Challenges and prospects. *Greener Journal of Environmental Management and Public Safety*, *6*(2), 18–33.

Arukwe, A., Eggen, T., & Möder, M. (2012). Solid waste deposits as a significant source of contaminants of emerging concern to the aquatic and terrestrial environments—A developing country case study from Owerri, Nigeria. *Science of the Total Environment*, *438*, 94–102.

Badmus, B. S., Ozebo, V. C., Idowu, O. A., Ganiyu, S. A., & Olurin, O. T. (2014). Physico-chemical properties of soil samples and dumpsite environmental impact on groundwater quality in South Western Nigeria. *The African Review of Physics*, *9*, 1–9.

Bouyoucos, G. J. (1962). Hydrometer method improved for making particle size analyses of soils. *Agronomy Journal*, *54*(5), 464–465.

Chikaodili, E. B., Iheanyichukwu, O. A., Kelechi, N. O., & Ikechukwu, N. E. (2019). Geochemical and bacteriological analyses of water resources prone to contamination from solid waste dumpsites in Imo State, Southeastern Nigeria.

Chudzicka-Czupała, A., Hapon, N., Chiang, S. K., Żywiołek-Szeja, M., Karamushka, L., Lee, C. T., Grabowski, D., Paliga, M., Rosenblat, J. D., Ho, R., & McIntyre, R. S. (2023). Depression, anxiety, and post-traumatic stress during the 2022 Russo-Ukrainian war: A comparison between populations in Poland, Ukraine, and Taiwan. *Scientific Reports*, *13*(1), 3602.

Chukwulobe, E. E., & Saeed, M. D. (2014). Assessment of some physicochemical properties and levels of Pb, Cu, and Zn in soils of selected dumpsites in Kano Metropolis, North-West, Nigeria. *International Journal of Biological and Chemical Sciences*, *8*(2), 717–726.

Ejiogu, B. C., Opara, A. I., Nwosu, E. I., Nwofor, O. K., Onyema, J. C., & Chinaka, J. C. (2019). Estimates of aquifer geo-hydraulic and vulnerability characteristics of Imo State and environs, Southeastern Nigeria, using electrical conductivity data. *Environmental Monitoring and Assessment*, *191*, 1–9.

Eyankware, R. O., Eyankware, M. O., & Effam, S. C. (2015). Soil erodibility assessment in selected parts of Ekwusigo Local Government Area, Anambra State, South-Eastern Nigeria. *International Journal of Innovation and Scientific Research*, *13*(1), 50–62.

Hosea, P. I., Olowokere, J. A., & Odineze, M. C. (2023). Comparative assessment of heavy metal concentration in some edible spinach (*Amaranthus hybridus*) in Southern Taraba (Ibi, Wukari and Donga), Nigeria. *Asian Journal of Applied Chemistry Research*, *14*(3), 10–16.

Justin, O. K., & O, A. G. B. N. (2018). Estimation and characterization of municipal solid waste in Nekede landfill, Owerri metropolis, Nigeria. *IJEAS*, *5*(3), 257249.

Nta, S. A., Ayotamuno, M. J., Igoni, A. H., & Okparanma, R. H. (2020). Soil quality as affected by municipal solid waste dumping. *Asian Soil Research Journal*, *3*(2), 1–1.

Obianefo, F. U., Agbagwa, I. O., & Tanee, F. B. (2017). Physicochemical characteristics of soil from selected solid waste dump sites in Port Harcourt, Rivers State, Nigeria. *Journal of Applied Sciences and Environmental Management*, *21*(6), 1153–1156.

Odika, I. M., Nwanisobi, G. C., Nwankwo, N. V., Mmaduakor, E. C., & Ikeh, O. A. (2020). Polycyclic Aromatic Hydrocarbons, PAHs contamination levels, and health risks in foods consumed in Nigeria: A review.

Ogala, J. E., Kalaitzidis, S., Rizos, A. M., Christanis, K., Omo-Irabor, O. O., Adaikpoh, E. O., Ejeh, O. I., & Papaefthymiou, H. (2020). Petrographic and mineralogical study of extended outcrops of lignite layers in the Agbor area, southern Nigeria. *Journal of African Earth Sciences*, *164*, 103659.

Ogoko, E. C. (2017). Physicochemical properties and heavy metal concentration of groundwater in Owerri Metropolis, Nigeria. *Current Journal of Applied Science and Technology*, *23*(1), 1–0.

Omeiza, A. J., Abdulwahab, O. O., Nur, M. S., Danjuma, T. T., Jaiyeoba, E., Abdullahi, D. U., Adekanye, O. O., & Mary, E. T. (2022). Effect of an active open dumpsite on the earth's subsurface and groundwater resource. *Asian Journal of Physical and Chemical Sciences*, *10*(2), 15–24.

Salam, L. B., Ilori, M. O., Amund, O. O., LiiMien, Y., & Nojiri, H. (2018). Characterization of bacterial community structure in a hydrocarbon-contaminated tropical African soil. *Environmental Technology*, *39*(7), 939–951.

Sarkar, B., Mukhopadhyay, R., Ramanayaka, S., Bolan, N., & Ok, Y. S. (2021). The role of soils in the disposition, sequestration, and decontamination of environmental contaminants. *Philosophical Transactions of the Royal Society B*, *376*(1834), 20200177.

Tamboli, P. M., & Nene, Y. L. (2013). Modernizing higher agricultural education system in India to meet the challenges of 21st century. *Asian Agri-History*, *17*(3), 251–264.

Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science*, *37*(1), 29–38.

Wunzani, D. K., Dauda, M. S., Wyasu, G., & David, D. A. (2020). Assessments of physicochemical properties and heavy metals content in soils from selected solid waste dumpsites in Kaduna Metropolis, Kaduna State, Nigeria. *Science World Journal*, *15*(1), 76–79.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/127200