Original Research Article

Comparative Evaluation of Radioactive Contamination in Soil Samples from Mining and Non-Mining communities of Barkin Ladi Local Government Area, Plateau State

ABSTRACT

Aims: To determine the level of radioactive pollution in soil samples from mining and non-mining communities in Barking Ladi local government area of plateau State and evaluate the implications for public health

Study design: A Comparative Study was conducted using soil samples collected randomly from mining and non-mining communities (four samples from each). The samples were subjected to analysis for gross alpha and beta radioactivity concentration at the Centre for Energy Research and Training, Ahmadu Bello University, Zaria, using a Protean Instrument Corporation (MPC 2000 Dual Phosphor) detector.

Results: The study revealed that the gross alpha activity concentration of the soil was in the range of 0.03747 ± 0.0150 to 0.04995 ± 0.0157 Bq/g, while beta activity concentration was in the range of 0.03995 ± 0.0301 to 0.1357 ± 0.0212 Bq/g. The maximum value of alpha activity concentration was 0.04995 ± 0.0157 Bq/g, and the maximum value of beta activity concentration was 0.1357 ± 0.0212 Bq/g.

Conclusion: The study shows that the radioactive concentrations in soils from both the mining and non-mining communities are below the World Health Organization's (WHO) recommended standard of 0.5Bq/l and 1.0Bq/l for gross alpha and gross beta in drinking water respectively. Even though these findings show that the soils from the study communities are safe for agricultural activities, it is essential to carry out routine monitoring activities to guard against potential radioactive pollution and protect public health.

Keywords: Radioactive Contaminants, Gross alpha and beta radioactivity, Mining activities, Soil Pollution, radionuclides

1. INTRODUCTION

The soil is a very essential part of the ecosystem because it provides an enabling environment to sustain plant growth (Pradhan et. al., 2023). Human activities such as mining tend to cause complications to the soil by releasing radionuclides in the environment making food crops produced on such soils to be harmful and not fit for human consumption (Ogundele, et. al., 2021).

In recent times, the global demand for mineral resources has further increased environmental degradation and enhanced the release of more radionuclides in the environment (Badamasi et al., 2023). In Nigeria the situation is exacerbated by the increasing number of illegal mining sites were radiological regulations are hardly followed resulting in poisoning and loss of life in some cases (Mark, 2014; Hassan, 2015).

Mining operations are capable of altering the physical, chemical and biological composition of the soil, thereby affecting the fertility of the soil (Ghose, 2004). This is because certain radionuclides such as Thorium, Potassium, and Uranium can be exposed to the surface of the soil during mining operations. Such radionuclides are hazardous to human health as they can pollute food and water (Eke et. al., 2024). According to a report by the United Nations Scientific Committee on the effect of Atomic radiation (UNSCEAR, 1988), these kind of pollution can expose humans to high dose of ionizing radiation leading to adverse heath challenges like cancer, genetic damage and a lot more. Soil degradation resulting from mining activities can also lead to food insecurity and poor quality food (Pozza & Field, 2020).

In some parts of Nigeria, like Barkin Ladi Local Government Area, Plateau State, the risk of being exposed to radiation is increased by the simultaneous operations of mining and crop production. The crops produced from such parts of the country are distributed and consumed all over the country and this can increase the chances of human exposure to ionizing radiation nationwide (Waida et al., 2022). This concern for increased risk of ionizing radiation to humans in the country has necessitated the call for increased radiological monitoring and regulation in mining areas so as to reduce this dangers (Muhammad et al., 2024). There are also concerns regarding the influence of mining activities on ecological balance and the microbes in the soil (Haghighizadeh et al., 2024).

One of the most common pathways of getting exposed to radiation is through the transfer of radionuclides from plants to humans through the food chain (Rout. et. al., 2021). In order to address the health concerns associated with mining activities, it is important to examine the distribution of alpha and beta activity levels in mining areas where farming activities are also

carried out. This study examines the alpha and beta activity levels of soil samples obtained from mining and non-mining areas of Barkin-Ladi Local Government area of Plateau state.

2. MATERIAL AND METHODS

2.1 Study Area

The Study area is Barkin Ladi Local Government area, Plateau state Nigeria. The area spans from latitudes 9^0 35' N and 9^0 45' N, and 8^0 45' E and 8^0 55' E. The area was selected based on the substantial mining operations carried out in the area due to its large mineral deposits. The mining locations were selected on the basis of subsisting mining activities. The non-mining locations on the other hand were selected as control locations with comparable ecological features.

2.2 Soil Sample

The stratified sampling technique was used to collect eight soil samples (four from mining locations and four from non-mining locations). From each location, about I kg of soil was taken from a depth of 0-20cm which represents the topmost layer susceptible to contamination. The soil samples were air dried at ambient temperature, crushed and sieved to obtain uniform particle size, and kept in air tight containers for radioactivity analysis.

2.3 Radioactivity analysis

The Protean Instrument Corporation (MPC 2000 Dual Phosphor) detector at Ahmadu Bello University, Zaria was used to analyze the gross alpha and gross beta activity in the soil samples. The detector had an alpha background of 0.5cmp and beta background of 0.73cmp with a detector efficiency of 87.95% and 42.06% for alpha and beta respectively

3. RESULTS AND DISCUSSION

Tables 1 and 2 shows the results of the radioactivity measurements of gross alpha and gross beta concentrations in soil samples collected at mining and non-mining locations in Barkin Ladi Local Government area of Plateau state.

Table 1: Sample Locations, IDs, and Descriptions

S/No	Sample Location	Sample ID	Sample Description
1	Atoso	Sample A	Tin Mining Area
2	Nafann Number Six	Sample B	Tin Mining Area
3	Rppiyam	Sample C	Non- Tin Mining Area
4	Kuppang	Sample D	Non- Tin Mining Area

Table 2: Gross Alpha and Gross Beta Activity Concentrations in Soil Samples Collected at Mining and Non-Mining Locations

S/No	Sample ID	Gross Alpha Activity (Bq/g)	Gross Beta Activity (Bq/g)
1	Sample A (Tin Mining Area)	0.03747 ± 0.0150	0.03995 ± 0.0301
2	Sample B (Tin Mining Area)	0.04997 ± 0.0157	0.1357 ± 0.0212
3	Sample C (Non-Tin Mining Area)	0.03364 ± 0.0123	0.04589 ± 0.0205
4	Sample D (Non-Tin Mining Area)	0.02937 ± 0.0109	0.05321 ± 0.0231

The analysis of soil samples from mining and non-mining areas reveals that there is a significant variation in gross alpha and gross beta activity concentrations between mining and non-mining areas. Notably, the samples which were taken from the mining regions (samples A and B) indicated remarkably higher levels of radioactive contaminations as compared to samples C and D which were taken from the non-mining regions. The remarkable difference obviously shows that mining activities contribute significantly to the rise in the level of radioactive contamination. The maximum levels of contamination was recorded at the mining area in Nanfan number six (Sample

B). The location had elevated gross alpha and beta values of 0.04997 $\pm$ 0.0157 Bq/g and 0.1357 $\pm$ 0.0212 Bq/g respectively

The good news is that the values obtained are all below the World Health Organizations recommended safety limit for drinking water of 0.5Bq/l for gross alpha and 1.0Bq/l for gross beta as indicated in tables 3. This is an indication that there low risk to human health in the region.

Table 3: Comparison of Gross alpha and Beta Activity Concentrations with World Health Organization's (WHO) Safe limits

Parameter	**Range of Measured Value (Bq/g)**	**Recommended safe Value (Bq/l)**
Gross Alpha Activity	0.02937- 0.04997	0.5
Gross Beta Activity	0.03995-0.1357	1.0

Although the current level of concentration of radioactivity within the study area is low and within acceptable limits, the study underscores the need for routing monitoring of radioactive contaminants in samples of soil in mining areas so as to minimize any possible health risk associated with radioactive exposures

4. CONCLUSION

In this study, the gross alpha and gross beta radioactivity levels in soil samples from mining and non-mining areas in Barkin-Ladi local Government area of Plateau Sate were measured. Findings from the analysis revealed that the activity levels of radioactive contaminants in the study area are below the recommended WHO safety limits of 0.5 Bg/l and 1.0 Bq/l in drinking water for alpha and beta activity levels, respectively. The results, however showed a remarkable difference in the activity levels between the mining and non-mining areas with the highest gross activity level of 0.04997 $\pm$ 0.0157 Bq/g in the mining area, and the least gross activity level of 0.02937 $\pm$ 0.0109 Bq/g from the non-mining area. The maximum gross Beta activity level of 0.1357 $\pm$ 0.0212 Bq/g was recorded at the mining area, while the least beta activity level of 0.03995 $\pm$ 0.0301Bq/g was recorded at the non-mining area. Despite the overall low level of radioactive contaminates

recorded, the study still emphasizes the necessity to embark on routine monitoring of radioactive concentration levels in mining areas to avoid unforeseen rise in radioactive concentration levels which can put the life of residents at risk.

REFERENCES

1. Pradhan, S., Bharteey, P. K., Bahuguna, A., Luthra, N., & Pal, S. (2023). Soil Health and It's Co-Relationship with Sustainable Agriculture. *Sustainable Management of Soil Health*, *1*.
2. Ogundele, L. T., Oluwajana, O. A., Ogunyele, A. C., & Inuyomi, S. O. (2021). Heavy metals, radionuclides activity and mineralogy of soil samples from an artisanal gold mining site in Ile-Ife, Nigeria: implications on human and environmental health. *Environmental Earth Sciences*, *80*(5), 202.
3. Badamasi, H., Hassan, U., Adamu, H., Baba, N., Adamu, D., & Baba, H. (2023). Assessment of Radiation Levels and Potential Radiological Hazards in the Soils of Riruwai Mining Area, North-Western Nigeria. *Journal of Pure & Applied Sciences*, *22*(1), 95-101.
4. Mark, M. (2014). Nigerians gold mining: farmers choose death by lead poisoning over poverty. *The Guardian Newspaper, March 17th*.
5. Hassan, M. M., Nuhu, A. A., Sallau, M. S., Majiya, H. M., & Mohammed, A. K. (2015). Zamfara lead poisoning saga: Comparison of lead contamination level of water samples and lead poisoning in Bagega Artisanal gold mining district, Nigeria. *Journal of Chemical and Pharmaceutical research*, *7*(3), 7-12.
6. Ghose, M. K. (2004). Effect of opencast mining on soil fertility. *Journal of Scientific and industrial research,* 63, 1006-1009.
7. Eke, B. C., Akomolafe, I. R., Ukewuihe, U. M., & Onyenegecha, C. P. (2024). Assessment of Radiation Hazard Indices Due to Natural Radionuclides in Soil Samples from Imo State University, Owerri, Nigeria. *Environmental Health Insights*, *18*, 11786302231224581.

8. United Nations Scientific Committee on the Effects of Atomic Radiation. (1988). Sources, effects and risks of ionizing radiation.
9. Pozza, L. E., & Field, D. J. (2020). The science of soil security and food security. *Soil Security*, *1*, 100002.
10. Waida, J., Rilwan, U., Jafar, M., Alkasim, A., & Yuguda, H. (2022). Contamination Factor of Radioactive Trace Elements (40K, 226Ra and 232Th) due to Mining Activities in Barkin Ladi and Mangu, Plateau State, Nigeria. *Water, Energy, Food and Environment Journal*, *3*(1), 1-12.
11. Muhammad, A. N., Ismail, A. F., & Garba, N. N. (2024). Natural radioactivity in food crops and soil and estimation of the concomitant dose from tin mining areas in Nigeria. *Journal of Taibah University for Science*, *18*(1), 2366507.
12. Haghighizadeh, A., Rajabi, O., Nezarat, A., Hajyani, Z., Haghmohammadi, M., Hedayatikhah, S., ... & Beni, A. A. (2024). Comprehensive analysis of heavy metal soil contamination in mining Environments: Impacts, monitoring Techniques, and remediation strategies. *Arabian Journal of Chemistry*, 105777.
13. Rout, S., Yadav, S., & Pulhani, V. (2021). Transfer of radionuclides from soil to selected tropical plants of Indian Subcontinent: A review. *Journal of Environmental Radioactivity*, *235*, 106652.