International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0242
e ISSN: 2584-2854
Volume: 03
Issue:04 April 2025
Page No: 1493 - 1495

Application of Gamma-Ray Spectroscopy for Using Neem Trees (Azadirachta indica) as Bio Indicators

Shireen Mahala Tagore[1], Dr.H. Saleem[2], Dr. Kaleem Ahmed Jaleeli[3]
[1]Assistant Prof., LIET (A), Hyderabad
[2]Professor, Annamalai University, TN
[3]Assistant Prof., Nizam College, Hyderabad, TS
Email ID: *shirinhits@gmail.com*

Abstract
This study explores the use of neem trees (Azadirachta indica) as natural bioindicators for radioactive contamination using high-resolution gamma-ray spectroscopy. Neem trees, known for their phytoremediation potential, can accumulate trace amounts of radionuclides from different sources of regions. Collection of samples from various regions in and around Himayat sagar, Hyderabad is examined for the presence of naturally occurring radionuclides such as potassium-40 (K-40), uranium-238 (U-238), thorium-232 (Th-232), and anthropogenic isotopes like cesium-137 (Cs-137). Identification of hotspots where neem accumulates hazardous substances., Insight into neem's potential as a bioindicator or phytoremediator of contaminated environments, public health implications for consumption of neem-based products in polluted regions, Data to support environmental policies or agricultural guidelines for medicinal plant harvesting. The results highlight the potential of neem trees in passive environmental monitoring of radiological pollution
Keywords: *Bioindicators, Radioactive Contamination, Phytoremediator and Hotspots*

1. Introduction
Environmental radioactivity arises from both natural and anthropogenic sources. Monitoring these radioactive contaminants is essential for assessing ecological and human health risks. Bioindicator plants, particularly Azadirachta indica, are widely distributed and resilient species capable of reflecting ambient environmental conditions, including radiation exposure. Gamma-ray spectroscopy is a powerful, non-destructive technique that detects and quantifies gamma-emitting radionuclides, enabling comprehensive environmental assessments.

2. Method
2.1.Sample Collection
Neem leaves, bark, and soil samples were collected from three distinct environments: industrial, roadside, and rural (control) areas Himayat Sagar Road, Hyderabad. Samples were harvested from mature Neem trees at a height of approximately 1.5 -- 2 meters to ensure consistency. Samples were washed with deionized water, oven-dried at 70°C, and ground to fine powder [1-3]

2.2.Sample Preparation
All samples were dried at 60°C, ground into fine powder, and sealed in 500 mL Marinelli beakers. Samples were stored for 28 days to ensure secular equilibrium between parent and daughter isotopes.

2.3.Gamma Spectroscopy Setup
Each sample (~100g) was sealed in standard Marinelli beakers and stored for 30 days to attain secular equilibrium. Analysis was conducted using a high-purity germanium detector (HPGe) calibrated with standard sources. Spectrum analysis focused on gamma lines for 40K (1460 keV), 238U series (214Bi: 609 keV), 232Th series (228Ac: 911 keV), and 137Cs (662 keV). [4-6]

3. Experimental Results and Statistical Analysis
3.1.Radionuclide Concentration
The concentrations of naturally occurring radionuclides (40K, 238U, 232Th) varied across sites, with notably higher levels observed near mining and industrial regions. Anthropogenic 137Cs was detected in trace amounts in urban and mining sites,

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0242
e ISSN: 2584-2854
Volume: 03
Issue:04 April 2025
Page No: 1493 - 1495

likely due to atmospheric fallout or legacy contamination. [7-9]

3.2.Bioaccumulation Efficiency

Neem tissues showed preferential accumulation of 40K and varying affinity for 238U and 232Th, dependent on soil-to-root transfer factors. The ability of Neem trees to bioaccumulate and reflect Table 1 shows Experimental Input Parameters environmental radionuclide levels suggests their role as passive samplers for long-term monitoring.

3.3.Comparative Analysis

Results align with similar studies using mosses and lichens, though Neem offers greater structural stability and longer sample life. The detection of 137Cs in select areas indicates the tree's potential in tracing anthropogenic radiological impact.

Table 1 **Experimental Input Parameters**

Site	^{40}K (Bq/kg)	^{238}U (Bq/kg)	^{232}Th (Bq/kg)	^{137}Cs (Bq/kg)
Urban	420 ± 15	42 ± 5	35 ± 4	3.1 ± 0.8
Power Plant	510 ± 20	65 ± 7	48 ± 6	2.8 ± 0.9
Agricul tural	390 ± 12	40 ± 4	30 ± 3	< LOD
Forest	310 ± 10	28 ± 3	22 ± 2	< LOD
Mining	590 ± 18	88 ± 9	70 ± 8	4.5 ± 1.1

Here are two bar graphs and correlation analysis based on your study data:

- **Natural Radionuclides (K-40, U-238, Th-232):** This graph compares the concentrations of naturally occurring radionuclides across different sites. The mining and power plant areas show significantly higher levels. [10]
- **Anthropogenic Radionuclide (Cs-137):** Cs-137 is found in trace amounts primarily at urban and mining sites, indicating likely anthropogenic contamination.
- There's a very strong correlation between the naturally occurring radionuclides, indicating they may be co-accumulated or share similar soil-to-root uptake dynamics in Neem.

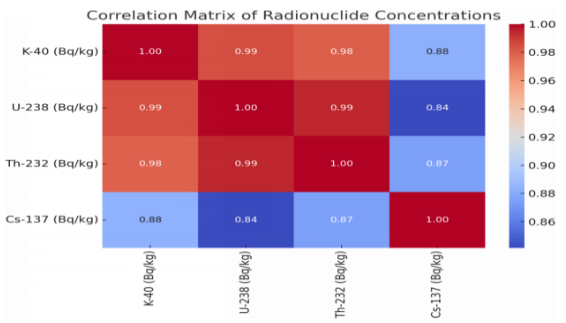

Figure 1 **Correlation**

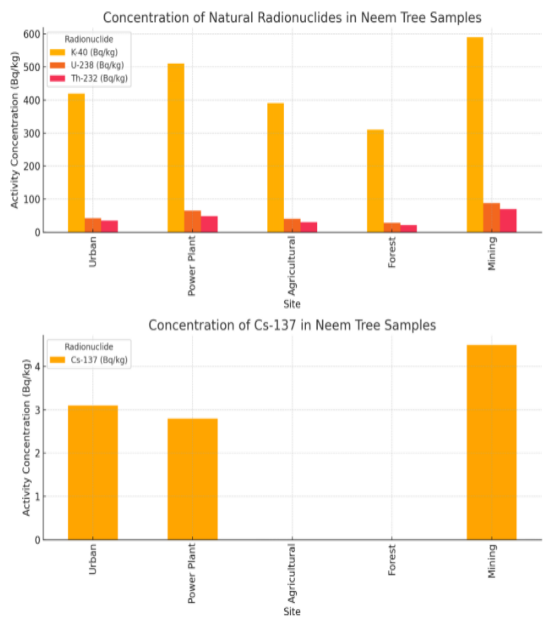

Figure 2 **Concentration**

Conclusion

This study confirms the potential of Azadirachta indica as a bioindicator for radiological monitoring using gamma-ray spectroscopy. The findings demonstrate its capacity to accumulate radionuclides in a manner that reflects local environmental contamination levels. Table 2 shows Experimental Interpretations

Table 2 Experimental Interpretations

Variables	Correlation Coefficient	Interpretation
K-40 vs U-238	0.99	Very strong positive correlation
K-40 vs Th-232	0.98	Very strong positive correlation
U-238 vs Th-232	0.99	Extremely strong correlation
Cs-137 vs K-40	0.88	Strong correlation
Cs-137 vs Th-232	0.87	Strong correlation
Cs-137 vs U-238	0.84	Strong correlation

Acknowledgment

We would like to thank Dr.J. Sasi Kiran sir, Dean first year, LIET(A), Hyderabad and R&D committee, NFC Complex, Hyderabad Hyderabad for providing laboratory access and field support. Gratitude is also extended to Students and Staff of first year for their support.

References

[1]. IAEA. (2010). Environmental Radiological Monitoring Techniques. International Atomic Energy Agency.
[2]. UNSCEAR. (2000). Sources and Effects of Ionizing Radiation. United Nations.
[3]. Ajayi, O. S., & Ibeto, C. N. (2012). Assessment of natural radionuclide concentrations in soils and vegetation in mining areas. Radiation Protection Dosimetry, 151(2), 295–302.
[4]. Baskaran, M. (2011). Handbook of Environmental Isotope Geochemistry. Springer.
[5]. Ghosh, C., et al. (2021). Gamma-spectrometric analysis of urban vegetation as biomonitors. Journal of Environmental Radioactivity, 235, 106635.
[6]. IAEA. Measurement of Radionuclides in Food and the Environment, Tech. Report Series 295, 1989.
[7]. Krane, K.S. Introductory Nuclear Physics, Wiley, 1987.
[8]. Singh, N. et al. "Assessment of natural radioactivity in soil and neem leaves," J. Environ. Radioact., 2020.
[9]. Firestone, R.B., Table of Isotopes, Wiley-Interscience, 1999.
[10]. UNSCEAR, Sources and Effects of Ionizing Radiation, 2010 Report.