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RADIOLOGICAL ASSESSMENTS OF (NORM) IN ROCKY PARTICLES USING GAMMA-RAY SPECTROMETER A CASE STUDY OF GRACELAND HANWA, ZARIA

[1]GAZARA, A.B., [1]SANDA, S. Y., [1]NAFIU, Y.[2]ISAH, U.
[1]Department of Science Laboratory Technology, Nuhu Bamalli Polytechnic, Zaria. [2]Shehu Idris College of Health Science and Technology, Makarfi.

ABSTRACT

The research titled Radiological Assessments of (NORM) in rocky particles using Gamma Ray Spectrometer. The three samples were collected from two ponds located at Hanwa Graceland, Zaria. The method used was Gamma ray spectroscopic using Sodium Iodide Gamma ray spectroscopy detector. The activity concentration of ^{232}Th, ^{226}Ra and ^{40}K in the study area which is one of the potential pathways where member of the public, animals and farm produce could be exposed was quantified using gamma ray spectroscopic analysis. The results have shown that ^{40}K has a mean concentration of 123.5421 Bq/kg in the range of 107.0413 – 148.3349 Bq/kg. Similarly, ^{232}Th has a mean concentration of 80.6777 Bq/kg in the range of 73.4377 – 94.2083 Bq/kg. Furthermore, ^{226}Ra has a mean concentration of 21.6113 Bq/kg in the range 2.23376 – 38.0789 Bq/kg. This shows that the Concentrations of ^{226}Ra and

Introduction:

Natural occurring radioactive material (NORM) is material found in the environment that contains radioactive elements of natural origin. The NORM can be found in Rock particles which are mainly natural radionuclide of the uranium (^{226}U) and thorium (^{232}Th) series, and the radioactive isotope of potassium (^{40}K). In the ^{238}U- series the decay chain segment starting from radium (^{226}Ra) is radiologically the most important and therefore, reference is often made to ^{226}Ra instead of ^{238}U (El-Taher*et al.,* 2003). These radionuclides are sources of the external and internal radiation exposures in dwellings. The external exposures is usually a result of direct gamma radiation

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^{40}K were found to be below standard limit, and that of ^{232}Th is higher than the standard limit. This implies that there is no problem based on the results obtained according to the United Nation Scientific Committee on the Effect Atomic Radiation (UNSCEAR, 2000) that all radioactive elements should be within 21 – 145 Bq/kg. This also shows that ^{226}Ra is the least available radionuclide in the study area followed by ^{232}Th which is more prevalent than ^{226}Ra. While ^{40}K is the most abundant radionuclide in the study area. Based on foregoing the following recommendations are hereby proposed: Determination of activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K by gross alpha and beta activity, and Internal exposure resulting from drinking water and ingestion of grasses containing Ra, Th and K by the cows should be undertaken in future.

***Keywords**: NORM, Radioactivity, Rocky particles, Radiation, Radionuclide.*

While the inhalation of radioactive inert gases radon (^{222}Rn, a daughter product of ^{226}Ra) and their short lived secondary product lead to the internal exposure of the respiratory tract to alpha particles (El-Taher *et al.,* 2003).

There are two main contributors to natural radiation exposures: high energy cosmic ray particle incident on the Earth's atmosphere and radioactive nuclides that originated from the earth crust and are present everywhere in the in the environment, including the human body (United Nations Scientific Committee on the Effects of Atomic Radiation [UNSCEAR], 2000).

Humans are exposed to radionuclides through ingestion and inhalation (internal exposure) and or radiation from external gamma rays emitted from radionuclide (external exposure). However the concentration of NORM in some natural substances (such as rock) is low that the risk is generally regarded as negligible. Higher concentrations may rise as a result of human activities. In most NORM, several or all of the radioactive isotopes of the three primordial decay series (^{235}U, ^{238}U and ^{232}Th) are present in small concentrations in the natural matrix. Irradiation of the human body from external sources is mainly gamma radiation from radionuclides of

^{235}U and ^{232}Th decay series and from ^{40}K. These radionuclides may be present in the body and irradiate various organs with alpha and beta particles as well as gamma rays (Duval *et al.*, 2009)

Rock

Rock or stone is a natural substance, a solid aggregate of one or more minerals or mineraloids. For example, granite, a common rock, is a combination of the minerals quartz. The Earth's outer solid layer, the lithosphere, is made of rock. Rock has been used by humankind throughout history. The minerals and metals in rocks have been essential to human civilization.

Three major groups of rocks are: igneous, sedimentary, and metamorphic. Rocks are composed of grains of minerals, which are homogeneous solids formed from a chemical compound arranged in an orderly manner. The aggregate minerals forming the rock are held together by chemical bonds. The types and abundance of minerals in a rock are determined by the manner in which it was formed. Many rocks contain silica (SiO_2); a compound of silicon and oxygen that forms 74.3% of the Earth's crust. This material forms crystals with other compounds in the rock. Many rocks contain silica (SiO_2); a compound of silicon and oxygen that forms 74.3% of the Earth's crust. The proportion of silica in rocks and minerals is a major factor in determining their names and properties.

About 7.9% of the earth crust by volume is composed of sedimentary rocks. Metamorphic rocks composed of 27.4% of the cruet by volume.The use of rocks has had a huge impact on the cultural and technological development of the human race. Rocks have been used by humans and other hominids for at least 2.5 million years(Robert *et al.,* 2005).

Determination of NORM in the general environment has become increasingly important during the past years. This may be due to most communities acknowledging the fact that elevated levels of NORM in the environment can be harmful to humans and animals (Rabiu, 2013). Hanwa is a place with many rocks. These include areas where there is a fish pond and cattle settlement in Graceland. These areas are surrounded by rocky particles. High concentration of radioactive substances in these rocky

particles may endanger the health of those cattle, human, plants and the fish in the pond.

Therefore there is need to probe the radiological hazard of the rocky particles for the people living in this important area.

AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to determine the activity concentrations of naturally occurring radioactive materials (NORM) in rocky particles at Graceland Hanwa, Zaria. The study has the following specific Objectives:

To determine the activity concentrations of naturally occurring radioactive materials (such as thorium, radium and potassium) in the two fish ponds located in Graceland Hanwa, Zaria.

To compare the obtained result with the standard.

To make the results a baseline for further researches in the future.

MATERIALS AND METHODS

Study Area and Location

The Graceland fish pond is located at latitude $11^{o}10^{1}$N and at longitude of $7^{o}70^{1}$E, in SabonGari Local Government Area of Kaduna State.

Sample collection

Bottom sediments were collected from the 3 different locations from the area mentioned above in period of low water levels during the dry season so that undisturbed sediments could be taken (Kabir *etal.*, 2008). The sediments were placed into different polyethylene bags and labeled and taken to Centre for Energy Research and Training, Ahmadu Bello University Zaria for analysis. The point of collection of each sample was given a unique code and noted with its GPS coordinate taken with a handheld GPS device.

Sediment Samples preparation For a Gamma Ray spectroscopy

The collected samples were kept opened to dry at an ambient temperature in the laboratory in a clean environment in order to avoid contaminations. The dried samples were grounded into a fine powder with the use of a table

ceramic mortar and pestle and then a pulverizer. The process was followed by packaging into radon impermeable cylindrical plastic containers of height 7cm by 6cm in diameter. This satisfied the selected optimal sample container height (Ibeanu, 1999) i.e the detector geometry. Each container would accommodate approximately 300g of sample. A 3-stage sealing system was made for each of the packaging to prevent Ra-222 from escape. This include, smearing of the inner rims of each container lid with Vaseline, filling the lid assembly gap with candle wax to block the gaps between lid and container and tight-seal lid container with a masking adhesive tape. The prepared samples were then stored for period of 30 days to allow radon and its short-lived progenies to reach secular radioactive equilibrium prior to gamma spectroscopy measurements.

Analytical techniques

Gamma ray spectrometric system

RESULTS AND DISCUSSION

The concentrations of k, Ra and Th extracted from the results of gamma ray spectroscopy analysis are shown in the table 1 below.

The results have shown that ^{40}K has a mean concentration of 123.5421 Bq/kg in the range of 107.0413 – 148.3349 Bq/kg. Similarly, ^{232}Th has a mean concentration of 80.6777 Bq/kg in the range of 73.4377 – 94.2083 Bq/kg. Furthermore, ^{226}Ra has a mean concentration of 21.6113 Bq/kg in the range 2.23376 – 38.0789 Bq/kg. This shows that the Concentrations of ^{226}Ra and ^{40}K were found to be below standard limit, and **^{232}Th** is higher than the standard limit. This also shows that ^{226}Ra is the least available radionuclide in the study area followed by ^{232}Th which is more prevalent than ^{226}Ra. While ^{40}K is the most abundant radionuclide in the study area.

S/NO	Sample ID.	Concentrations (Bq/Kg)		
		^{232}Th	^{226}Ra	^{40}K
1	Sample 1	74.5488	38.0789	107.0413
2	Sample 2	79.0705	2.23376	148.3349
3	Sample 3	94.2083	15.4233	119.5367

4	Sample 4	82.1232	28.5783	129.1234
5	Sample 5	73.4377	23.7422	113.6743
Average Concentrations		80.6777	21.6113	123.5421
UNSCEAR avrg Standard limits		30.00	35.00	400

Key: UNSCEAR; United Nations Scientific Committee on Effects of Atomic Radiation (2000).

CONCLUSION

The Natural Occurring Radiological Material (NORM) in rocky particles of two fish ponds located at Graceland, Hanwa Zaria was quantified using the method of Gamma ray spectroscopic using Sodium Iodide Gamma ray spectroscopy detector. The activity concentration of ^{232}Th, ^{226}Ra and ^{40}K in the study area which is one of the potential pathways where member of the public, animals and farm produce could be exposed was quantified using gamma ray spectroscopic analysis. The results have shown that ^{40}K has a mean concentration of 123.5421 Bq/kg in the range of 107.0413 – 148.3349 Bq/kg. Similarly, ^{232}Th has a mean concentration of 80.6777 Bq/kg in the range of 73.4377 – 94.2083 Bq/kg. Furthermore, ^{226}Ra has a mean concentration of 21.6113 Bq/kg in the range 2.23376 – 38.0789 Bq/kg. This shows that the Concentrations of ^{226}Ra and ^{40}K were found to be below standard limit, and that of **^{232}Th** is higher than the standard limit. This implies that there is no problem based on the results obtained according to the United Nation Scientific Committee on the Effect Atomic Radiation (UNSCEAR, 2000) that all radioactive elements should be within 21 – 145 Bq/kg. This also shows that ^{226}Ra is the least available radionuclide in the study area followed by ^{232}Th which is more prevalent than ^{226}Ra. While ^{40}K is the most abundant radionuclide in the study area. Based on foregoing the following recommendations are hereby proposed: Determination of activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K by gross alpha and beta activity, and Internal exposure resulting from drinking water and ingestion of grasses containing Ra, Th and K by the cows should be undertaken in future.

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