Investigation of Radionuclide Concentration on an Agricultural Farm at Osun State University, Ejigbo Campus

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ABSTRACT

The study of the radionuclide concentration on an agricultural farm at Osun State University, Ejigbo campus was carried out using soil samples collected from the available farmlands and fish-ponds. This study is to provide a baseline data on the radiation level as well as the distribution of some naturally occurring radionuclides of potassium, uranium and thorium present on the agricultural farm that was established in 2007.

The analysis was carried out through the use of a well-calibrated Gamma ray spectrophotometer NaI (Tl) detector system. The range of activity concentration of the radionuclides for 40K, 238U and 232Th, was found to be (117.51 ± 7.79 to 232.85 ± 5.39, 55.81 ± 4.65 to 102.12 ± 4.96 and 1.52 ± 0.86 to 3.29 ± 1.01) Bq / Kg, respectively.

(Keywords: radionuclides, agricultural farm, farmlands, fish-ponds, gamma radiation, concentration, sodium iodide, health physics)

INTRODUCTION

The global interest in the study and survey of naturally occurring radiation and environmental radioactivity had been essentially based on the importance of using the results from such studies for the assessment of public radiation exposure rates and the performance of epidemiological studies, as well as reference radiometric data relevant in studying the possible changes in environmental radioactivity due to nuclear, industrial, and other human technology-related activities (UNSCEAR, 2000).

It has been established that out of the total radiation dose that the world population receives, about 96.1% is from natural sources and the remainder is from human made sources (Chougankar *et al*., 2003). The natural environmental radioactivity in a location and its associated external exposure due to Gamma radiation depends primarily on its geological and geographical conditions (Akinloye et al., 2012; Isola et al., 2018). It is related to the composition of each lithology separating the area and the content of the rock from which the soil originates. Therefore, the specific concentration levels of terrestrial radiation differ in the soil of each region of the world (Akhtar *et al*., 2004).

The study of the distribution of radionuclides in the human environment allows the understanding of the radiological implications of these elements due to the gamma-ray exposure of the body and irradiation of lung tissues from inhalation of radon and its daughters. Hence, this study is necessitated by the fact that no previous work has been conducted to provide a database on the distribution of radionuclides and their concentrations. Since radiation cannot be felt by the human sense organs, it is important that the amount of the naturally occurring radionuclide concentration in the part of the institution be determined in order to safeguard the life of people and ensure radiation-pollution free environment.

This study is to estimate the activity concentration of radionuclides in the soil samples. Each radionuclide is characterized by its own half-life, which is the time required for half of the radioactive substance to undergo spontaneous decay. It is the nucleus of atom that exhibits the properties of spontaneous disintegration. Radionuclides can be used to calculate the age of rocks and minerals using radiometric dating method. Naturally occurring radioactivity is common in the rocks and minerals as well as the soil that make up the planet. Also, they exist in the homes, building materials and so on.

MATERIALS AND METHOD

The materials used in this study are mortar and pestle, aluminum foil, sieving mesh (2mm), masking tape, plastic containers and the list of equipment are analytical weighing balance (Mettler FA2104A), Gamma ray spectrophotometer NaI (TI) absorption detector for Electrons and Gamma-rays.

The sample collection, preparation, and analysis were carried out as follows: sixty soil samples were collected from various farmlands and fish-ponds at different locations at a depth of 3 to 15 cm each. The samples were air-dried, crushed, and homogenized. The homogenized samples were packed and hermetically sealed in plastic containers with the aid of Polyvinyl Chloride (PVC) tape to prevent the escape of airborne ^{222}Rn and ^{220}Rn from the samples.

All the samples were weighed and stored for twenty-eight days prior to measurement in order to attain radioactive secular equilibrium between Radon and its decay products. After the secular equilibrium period was attained, samples were weighed using a well calibrated Mettler weighing balance (FA2104A) where each sixty samples were weighed 200 grams in the laboratory.

The samples were afterwards placed in a NaI (Tl) absorption detector with a lead shield to reduce the effect of background radiation. The spectrometer was tested for its linearity and then calibrated for energy using Gamma sources. The channel numbers of the photo-peaks corresponding to the different Gamma energies were recorded. The efficiency calibration curve for the NaI (TI) absorption detector for Electrons and Gamma-rays was obtained.

RESULTS AND DISCUSSION

The results obtained in this study are presented in Table 1, with FSS as Farm Soil Sample.

Table 1, summarizes the mean values of the activity concentration of the radionuclides for each the Farm Soil Sample (FSS). The activity concentration distributions could be as a result of the fact that the area of the land was kept undisturbed after it was being fertilized (Araromi, *et al*., 2016).

Table 1: Activity Concentration in Soil Samples.

SAMPLE	K-40 (Bq/kg)	U-238 (Bq/kg)	Th-232 (Bq/kg)
FSS 1	197.29 ±4.36	90.47 ±3.60	3.02 ±0.86
FSS 2	200.76 ±4.74	93.07 ±3.95	3.05 ±0.88
FSS 3	183.85 ±2.36	80.85 ±1.84	2.87 ±0.77
FSS 4	196.42 ±4.26	88.21 ±3.28	2.98 ±0.84
FSS 5	169.11 ±3.02	68.41 ±3.00	1.72 ±0.73
FSS 6	189.92 ±2.41	82.55 ±2.25	2.81 ±0.73
FSS 7	152.63 ±1.06	70.68 ±2.60	2.00 ±0.51
FSS 8	164.77 ±1.66	68.47 ±2.99	2.07 ±0.44
FSS 9	175.61 ±1.61	69.32 ±2.85	1.76 ±0.71
FSS 10	178.21 ±0.14	70.34 ±2.66	1.82 ±0.66
FSS 11	202.06 ±4.88	93.12 ±3.95	3.06 ±0.89
FSS 12	186.45 ±2.86	83.17 ±2.39	2.92 ±0.80
FSS 13	182.12 ±1.96	74.07 ±1.83	1.94 ±0.56
FSS 14	189.92 ±3.41	85.21 ±2.78	2.96 ±0.83
FSS 15	183.42 ±2.27	82.78 ±2.30	2.63 ±0.60
FSS 16	232.85 ±5.39	102.12 ±4.96	3.29 ±1.01
FSS 17	195.12 ±4.10	83.68 ±2.49	2.31 ±0.21
FSS 18	216.80 ±5.21	101.10 ±4.86	3.16 ±0.90
FSS 19	179.51 ±1.13	80.97 ±1.87	2.40 ±0.36
FSS 20	196.86 ±4.31	82.27 ±2.15	2.55 ±0.53
FSS 21	163.90 ±3.78	68.87 ± 2.92	1.92 ±0.58
FSS 22	138.32 ±6.31	64.12 ±3.65	1.87 ±0.62
FSS 23	162.17 ±4.01	70.68 ±2.60	2.03 ±0.48
FSS 24	187.75 ±3.08	88.43 ±3.31	2.75 ±0.69
FSS 25	192.52 ±3.77	89.34 ±3.44	2.80 ±0.72
FSS 26	164.7 7±3.66	68.98 ±2.90	1.93 ±0.57
FSS 27	173.01 ±2.28	67.28 ±3.18	1.74 ±0.72
FSS 28	160.01 ±4.27	67.91 ±3.08	1.98 ±0.52
FSS 29	163.91 ±3.78	72.20 ±2.28	2.20 ±0.25
FSS 30	117.51 ±7.79	55.81 ±4.65	1.52 ±0.86
FSS 31	144.39 ±1.81	68.36 ±3.01	1.91 ±0.59
FSS 32	125.31 ±1.27	56.54 ±4.57	1.57 ±0.83
FSS 33	174.31 ±1.98	69.55 ±2.81	1.85 ±0.64
FSS 34	179.95 ±1.30	67.96 ±3.07	2.19 ±0.26
FSS 35	157.40 ±4.56	72.49 ±2.22	2.16 ±0.31
FSS 36	160.43 ±4.21	73.50 ±1.98	2.19 ±0.27
FSS 37	151.76 ±5.14	71.24 ±2.49	1.96 ±0.55
FSS 38	173.44 ±2.18	79.16 ±1.30	2.31 ±0.21
FSS 39	162.17 ±4.01	63.16 ±3.78	1.75 ±0.71
FSS 40	177.35 ±0.94	75.26 ±1.47	2.20 ±0.24
FSS 41	178.65 ±0.64	75.37 ±1.44	2.17 ±0.30
FSS 42	185.15 ±2.62	84.13 ±2.58	2.43 ±0.40
FSS 43	173.44 ±2.18	64.17 ±3.64	1.92 ±0.58
FSS 44	196.42 ±4.26	82.32 ±2.20	2.21 ±0.24
FSS 45	182.12 ±1.96	84.64 ±2.68	2.21 ±0.22
FSS 46	186.02 ±2.78	68.87 ±2.92	1.95 ±0.55
FSS 47	182.55 ±2.07	69.43 ±2.83	1.93 ±0.58
FSS 48	173.88 ±2.08	68.02 ±3.07	1.88 ±0.62
FSS 49	209.00 ±5.54	74.86 ±1.61	2.09 ±0.42
FSS 50	191.23 ±3.60	85.38 ±2.81	2.10 ±0.40
FSS 51	195.56 ±4.16	93.75 ±4.02	2.25 ±0.11
FSS 52	186.45 ±2.86	81.53 ±2.02	2.16 ±0.32
FSS 53	202.93 ±4.96	94.93 ±4.18	2.97 ±0.84
FSS 54	176.48 ±1.32	66.66 ±3.28	1.78 ±0.69

FSS 55	180.81 ±1.60	90.92 ±3.67	2.32 ±0.23
FSS 56	176.48 ±1.32	80.91 ±1.86	2.16 ±0.32
FSS 57	186.02 ±2.78	78.82 ±1.17	2.14 ±0.34
FSS 58	176.04 ±1.47	66.32 ±3.33	1.93 ±0.57
FSS 59	174.31 ±1.98	79.38 ±1.39	2.18 ±0.28
FSS 60	176.91 ±1.15	95.10 ±4.20	3.04 ±0.88

If we compare the results of the activity concentration with the world average for soils, it can be observed that the average values of the activity concentrations of radionuclides in the soil samples collected are in within the range and in agreement of the world value (Araromi, *et al*., 2016). Table 2 shows the comparison between the average values for the radionuclide concentration of this study, world and some countries around the world.

Table 2: Comparison of the Average Values of this Study Radionuclides with World Values.

Place of sample	K-40 (Bq/Kg)	U-238 (Bq/Kg)	Th-232 (Bq/Kg)	References
World average	400	30	35	UNSCEAR, 2000
Osun State University, farm land at Ejigbo campus, Nigeria	178	78	2.3	This study, 2019
University of Ibadan, Oyo State, Nigeria	207.19	-	16.73	Araromi, *et al*., 2016
Syrian	270	-	20	UNSCEAR, 2000
Denmark	460	-	17	UNSCEAR, 2000
Italy	602 – 792	-	>74 – 86	Bellia, *et al*., 1997
Cyprus	317 – 730	-	< 4 – 40	Tzortzis, *et al*., 2004
USA	370	35	35	Myrick, *et al*., 1983

From Table 2, the average concentration values of K-40 and Th-232 radionuclides were lower than that of the world values, while that of the U-238 was found to be higher than that of the world value. This means that there can be some serious health risks it poses for the people living in the area, those working in the area, students living in the area or those buying their farm products, for the U-238, if the nucleus becomes unstable, but for the K-40 and Th-232, the stability can of the atom might not be worrisome, since it is found to be far less compared to the world average values.

Figure 1 shows the contrast of the average values between this study and the world.

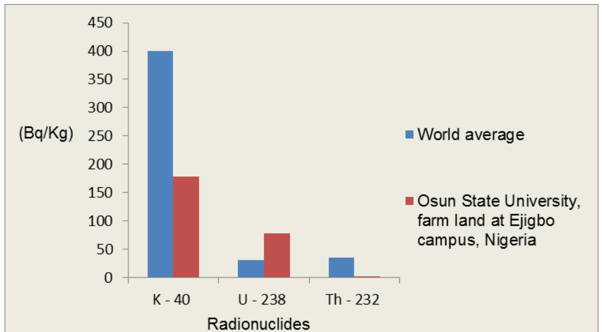

Figure 1 : Contrast of the average values of this study with the world

CONCLUSION

The activity concentration of the radionuclides on farmland on the average can be found to be steady for the K–40 and Th-232, but not for the U–238. The U–238 can be an unstable nucleus afterwards because of its higher average value than that of the world. This means that proper caution and care has to be taken in dealing with this type of radionuclide in order not to incur any health hazards or carcinogenic risk. Furthermore, the knowledge of the radionuclide content of soils is central to the establishment of environmental baselines for various substrates and environments (Jordan *et al*., 1997).

REFERENCES

1. Akhtar, N., M. Tufail, M. Ashraf, A. Moshin and M. Iqbad. 2004. “Measurement of Environmental Radioactivity for the Estimation of Radiation Exposure from Saline Soil of Lahore, Pakistan”. *Radiation Measurements*. 39(2):11 – 14.

2. Akinloye, M.K., G.A. Isola, and O.O. Oladapo. 2012. “Investigation of Natural Gamma Radioactivity Levels and Associated Dose Rates

from Surface Spills in Ore Metropolis, Ondo State, Nigeria". *Environmental and Natural Resources*. 2(1):140 – 145.

3. Araromi, O.I., A.O. Ojo, M.O. Olaluwoye, and O.B. Odefemi. 2016. "The Concentration of Natural Radionuclides in Soil Samples from the Practical Year Agricultural Farmland, University of Ibadan". *IOSR Journal of Applied Physics (IOSR – JAP)* e – ISSN: 2278 – 4861. Volume 8, Issue 4 Ver. III (Jul. – Aug. 2016): 60 – 68.

4. Chougankar, M.P., K.P. Eppen, and T.V. Ramachandra. 2003. "Profiles of Doses to Population Living on the High Background Radiation areas in Kerala". *J. Environ. Radioactivity*. 71: 275 – 295.

5. Bellia, S., M. Brai, S. Hauser, P. Puccio, and S. Rizzo. 1997. "Natural Radioactivity in a Volcanic Island Usta, Southern Italy". *Radl. Isot*. 48: 287 – 293.

6. Jordan, C., J.G. Cruickshank, J.A. Higgins, and K.P. Hamil. 1997. *The Soil Geochemical Atlas of Northern Ireland.* Department of Agricultural for Nothern Ireland: Belfast. UK.

7. Isola, G.A., O.M. Oni, M.K. Akinloye, and P.S. Ayanlola. 2018. "Measurement of Natural Radioactivity in Soil Samples from Ladoke Akintola University of Technology, Ogbomoso South – West, Nigeria". *International Journal of Scientific and Research Publications*. 8(8). ISSN 2250 – 3153.

8. Myrick, T.E., B.A. Berven, and F.F. Haywood. 1983. "Determination of Selected Radionuclides in Surface Soil in the U.S". *Health Physics* 45930:631 – 642.

9. Tzortzis, M. and H. Tsertos. 2004. *Determination of Thorium, Uranium and Potassium Element Concentration in Surface Soils in Cyprus*. Department of Physics, University of Cyprus: Nicosia, Cyprus.

10. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2000. "Reports to the General Assembly New York with Scientific Annexes". VOLUME I. UNSCER: New York, NY.

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