HEALTH DETRIMENT ASSOCIATED WITH EXPOSURE TO NATURAL RADIOACTIVITY FROM THE SOIL OF ONDO AND EKITI STATES SOUTH WESTERN, NIGERIA

A. E. AYODELE[1], A. M. AROGUNJO[1,2], J. I. AJISAFE[1, 3] and O.T. ARIJE[1]
[1]Department of Physics, Federal University of Technology, Akure, Nigeria, [2]University of Medical Sciences , Ondo, Nigeria
[3] Department of Industrial Safety and Environmental Engineering Technology, Petroleum Training Institute, Effurun, Warri, Nigeria.
Corresponding e-mail: erastcalc@yahoo.com

ABSTRACT

The health detriment associated with primordial radionuclides from the earth crust has been a major source of concern to public health observers across the globe. The level of such detriment can be mitigated by constant monitoring in order to ascertain that the safe threshold is maintained from time to time. In the light of the above, the activity concentrations of natural occurring radioactivity (i.e. ^{232}Th, ^{226}Ra and ^{40}K) were determined in seventeen soil samples collected from selected cities across Ondo and Ekiti states using an n-type coaxial HPGe gamma ray detector with ORTEC multichannel analyzer (MCA) and MAESTRO-32 for spectrum analysis and processing. The measured activity concentrations ranged from 31.93 1.77 to 227.50 4.43 Bq Kg^{-1} ^{232}Th, 364.89 6.40 to 1274.57 12.48 Bq Kg^{-1} ^{40}K, 45.60 2.99 to 210.36 8.76 Bq Kg^{-1} ^{226}Ra and 48.64 2.04 to 207.22 5.50 Bq Kg^{-1} ^{232}Th, 542.26 10.41 to 2348.86 21.83 Bq Kg^{-1} ^{40}K and 73.52 3.81 to 209.15 7.45 Bq Kg^{-1} ^{226}Ra for Ondo and Ekiti states respectively. Absorbed dose was calculated using the measured activity concentrations. The mean absorbed dose rate and standard deviation in nGyh^{-1} were 140.89 65.27 and 173.27 85.40 respectively for the two States. Health detriment to various organs of the body resulting from the exposure scenario was evaluated.

METHODOLOGY

In this work, 17 samples of soil were collected from selected cities across *Ondo* and *Ekiti* states and analysed for primordial radionuclides using gamma-ray Spectrometry to evaluate the activity concentration, absorbed dose due to exposure and the associated health detriment to different organs of the body.

At each of the designated locations, the soil samples were taken from a depth of 10 cm. About 120 g of each of the samples were packaged in cellophane bags and labelled. The collected soil samples were transferred to the laboratory where they were oven dried at a temperature of 110 ^{o}C to a constant mass. The dried samples were then pulverized and sieved using a 2 mm mesh. The samples was left untouched for about three or four weeks to allow the samples achieve secular equilibrium between parent and daughter nuclides prior to analysis.

Table 1.0: Activity Concentrations of Radionuclides in Ondo and Ekiti State Soil Samples

LOCATION	S/N	Activity (Bq kg^{-1})					
		Sample	Th – 232	K-40	Ra - 226	Cs -137	Ra_{eq} (Bq kg^{-1})
ONDO	1	IS_3 – SOIL	36.42 ± 1.64	364.89 ± 6.40	48.09 ± 2.89	2.00 ± 0.33	125.71
	2	HS_3 – SOIL	62.84 ± 2.21	1274.57 ±12.48	45.60 ± 2.99	1.85 ± 0.32	224.68
	3	KS_5 – SOIL	31.93 ± 1.77	627.56 ± 10.65	82.21 ± 4.93	2.08 ± 0.36	171.80
	4	IS_2 – SOIL	80.21 ± 3.64	934.81 ± 12.64	71.40 ± 4.44	3.02 ± 0.62	251.54
	5	HS_2 – SOIL	93.46 ± 4.43	1047.62 ±18.25	108.00 ± 6.79	4.55 ± 0.88	314.18
	6	ES_1 – SOIL	227.50 ± 4.43	1165.50 ±13.54	210.36 ± 8.76	5.03 ± 0.56	612.67
	7	ES_2 – SOIL	94.83 ± 2.65	628.09 ± 10.04	84.61 ± 5.09	3.10 ± 0.47	264.18
	8	AS_5 – SOIL	115.47 ± 3.03	908.35±11.24	146.08 ± 6.38	4.83 ± 0.50	374.79
	9	AS_1 – SOIL	83.16 ± 4.27	1115.39± 20.79	113.70 ± 7.22	2.82 ± 0.88	310.70
EKITI	1	OS_3 – SOIL	79.19 ± 4.01	683.49 ± 11.86	85.28 ± 4.49	BD	246.37
	2	TS_1 – SOIL	48.64 ± 2.04	1487.76 ±18.50	100.90 ± 6.14	5.51 ± 0.79	274.60
	3	TS_3 – SOIL	207.22 ± 5.50	2292.23± 21.14	209.15 ± 7.45	8.22 ± 0.93	665.93
	4	SS_3 – SOIL	104.49 ± 3.03	1248.96± 15.78	111.68 ± 5.09	3.97 ± 0.54	348.53
	5	SS_1 – SOIL	105.00 ± 2.41	807.94 ± 10.50	104.04 ± 4.12	3.09 ± 0.46	310.75
	6	OS_2 – SOIL	72.40 ± 3.18	754.44 ± 12.68	84.56 ± 5.05	BDL	240.90
	7	QS_2 – SOIL	176.28 ± 4.93	2348.86± 21.83	181.87 ± 8.22	8.88 ± 0.82	598.37
	8	MS_5 –SOIL	52.54 ± 2.90	542.26 ± 10.41	73.52 ± 3.81	3.31 ± 0.47	186.61

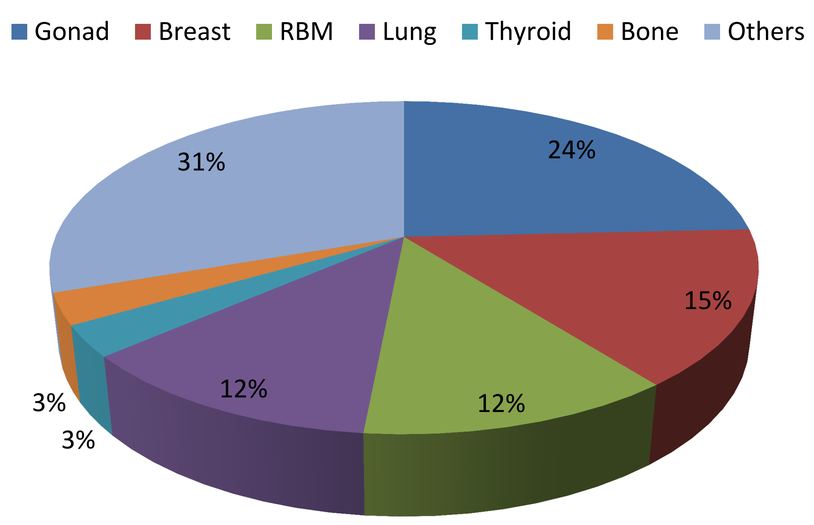

Figure 1.0: Percentage Distribution of Health Detriment From the Soil of Ondo state to different Organs of the Body

Table 2.0: Comparison of activity concentration of ^{40}K, ^{226}Ra and ^{232}Th in Soil measured worldwide.

Country	Activity concentration (Bqkg^{-1})		
	^{40}K	^{226}Ra	^{232}Th
Pakistan (Punjab)	615 ± 143	35 ± 7	41 ± 8
Cyprus	105 ± 95	7.1 ± 8.6	5.0 ± 7.1
Alexandria, Egypt	262 ± 82	16.7 ± 2.7	19.4 ± 5.0
South India	117.5	35	29.8
Spain	650	46	49
Kenya	255 ± 38.5	28.7 ± 3.6	73.3 ± 9.1
China	578 ± 164	42.7 ± 15	46.3 ± 12
Republic of Ireland	350	60	26
Saudi Arabia	225 ± 63	14.5 ± 3.9	11.2 ± 3.9
Ondo State (Nigeria)	849.03 ± 12.89	101.12 ± 5.50	91.76 ± 3.12
Ekiti State (Nigeria)	1270.74 ± 15.34	118.88 ± 5.55	105.72 ± 3.50
World's average	400	35	30

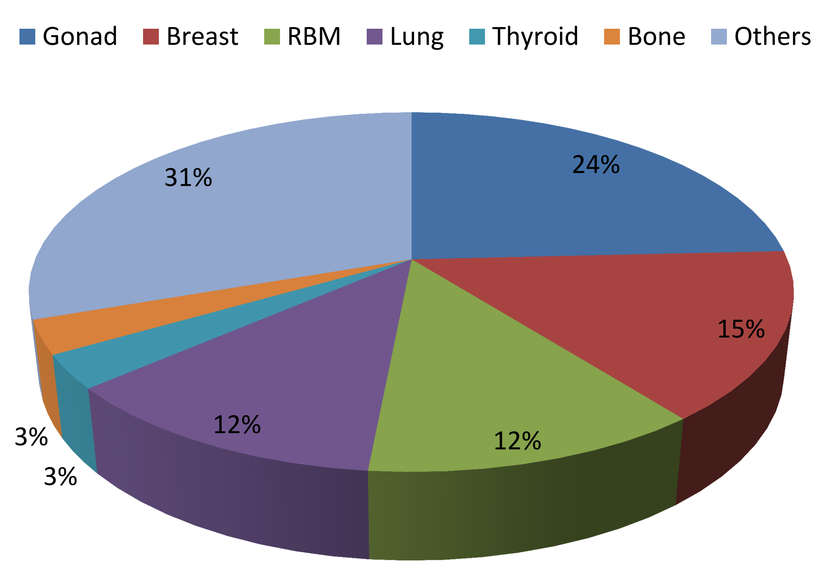

Figure 2.0: Percentage Distribution of Health Detriment From the Soil of Ekiti state to different Organs of the Body

CONCLUSION

This study investigated the activity concentrations of soil samples taken from selected locations across Ondo and Ekiti States, the radiological health detriment resulting from exposure to different organs of the body and the Radium equivalent index was also evaluated. Measured activity concentrations recorded in this work ranged from 31.93 1.77 - 227.50 4.43 Bq Kg^{-1} ^{232}Th, 364.89 6.40 - 1274.57 12.48 Bq Kg^{-1} ^{40}K, 45.60 2.99-210.36 8.76 Bq Kg^{-1} ^{226}Ra and 48.64 2.04 - 207.22 5.50 Bq Kg^{-1} ^{232}Th, 542.26 10.41 - 2348.86 21.83 Bq Kg^{-1} ^{40}K 73.52 3.81 - 209.15 7.45 Bq Kg^{-1} ^{226}Ra for Ondo and Ekiti states respectively. These values are found to be above those reported from other parts of the World and the World average value. Annual outdoor effective dose equivalent was also calculated using a dose conversion factor of 0.7 Sv Gy^{-1} for the two states. The results were found to be above the 70 $\mu Sv\ y^{-1}$ recommended by ICRP and below the world average of 1 mSv y^{-1}. The calculated mean Radium equivalent index for Ondo and Ekiti States are 295.07 Bq Kg^{-1} and 359.01 BqKg^{-1} respectively. These values are still below the international standard of 370 BqKg^{-1} ^{226}Ra; hence the area under investigation is still safe for Human habitation. Health detriment to various organs of the body resulting from exposure to these radionuclides was also evaluated.

SOME REFERENCES

United Nations Scientific Committee on Effects of Atomic Radiation, '' Sources and Effects of ionizing Radiation'', UNSCEAR Report, New York, 1993.

United Nations Scientific Committee on Effects of Atomic Radiation, (UNSCEAR), 2000: Report to General Assembly, Report Vol 1. Sources and Effects of Ionizing Radiation, with Scientific Annexes, United Nations, New York.

McAulay, I.R. and Morgan, D., (1988): Natural Radioactivity in Soils in the republic of Ireland, Radiat. Prot. Dosimetry 24 (1/4), 47- 49.

Jibiri, N. N., Alausa, S. K. and Farai, I. P. (2009) : Radiological hazard indices due to activity concentrations of natural radionuclides in farm soils from two high background radiation areas in Nigeria. Int. J. Low Radiation, 6,(2), 79-95.

RADIOACTIVITY LEVEL OF DRILLED WELL WATER ACROSS SELECTED CITIES IN ONDO AND EKITI STATES, SOUTHWESTERN NIGERIA AND ITS RADIOLOGICAL IMPLICATIONS.

A. E. AYODELE[1], A. M. AROGUNJO[1,2], J. I. AJISAFE[1, 3] and O.T. ARIJE[1]
[1]Department of Physics, Federal University of Technology, Akure, Nigeria, [2]University of Medical Sciences , Ondo, Nigeria
[3] Department of Industrial Safety and Environmental Engineering Technology, Petroleum Training Institute, Effurun, Warri, Nigeria.
Corresponding e-mail: erastcalc@yahoo.com

INTRODUCTION

Dug and drilled well are the major sources water available for human use in town and cities of Nigeria. Hence, this work is intend to assess the level of physical contaminants (i.e. radionuclides) present in Eleven drilled well distributed across selected cities in Ondo (5^0 48'N, 4^0 45'E) and Ekiti States (8^0 15'N, 6^0 05'É), South Western Nigeria using high resolution gamma ray Spectrometry. The age dependent annual effective dose accrued to individual due to exposure will also be calculated

METHODOLOGY

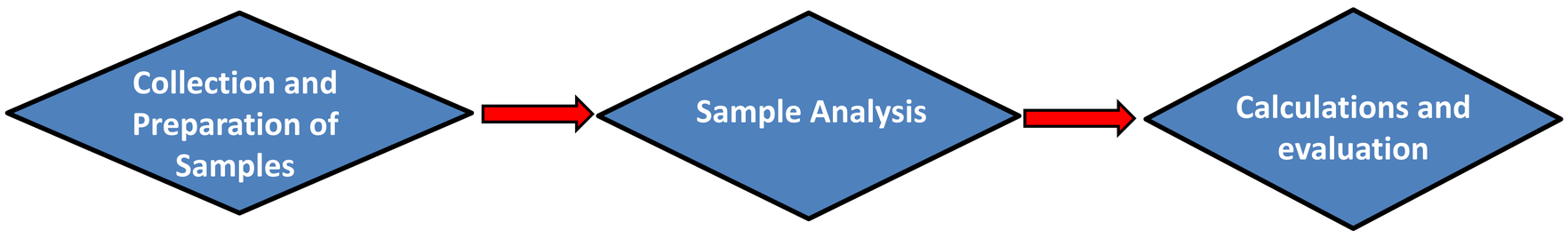

Table 2.0: Annual Effective Dose for Three Different age Groups and Committed Effective Dose resulting from Ekiti and Ondo Drilled Well Water Samples.

Sample	Radionuclide	Activity Conc. Bql^{-1}	Annual Effective Dose, (0-1y) mSvy^{-1}	Annual Effective Dose, (7-12y) mSvy^{-1}	Annual Effective Dose, (>17y) mSvy^{-1}	Committed Effective Dose(>17y) mSvy^{-1}
O - BH	Th-232	4.10 ± 0.76	3.77 ± 0.70	0.42 ± 0.08	0.69 ± 0.13	143 ± 21.70
	K-40	78.93 ± 3.84	0.98 ± 0.05	0.36 ± 0.02	0.36 ± 0.02	
	Ra-226	8.92 ± 1.42	8.38 ± 1.33	2.50 ± 0.40	1.82 ± 0.29	
Total			13.10 ± 2.08	3.27 ± 0.50	2.87 ± 0.43	
T – BH	Th-232	2.43 ± 0.59	2.24 ± 0.54	0.25 ± 0.06	0.41 ± 0.10	92.00 ± 18.20
	K-40	41.50 ± 2.89	0.52 ± 0.04	0.19 ± 0.01	0.19 ± 0.01	
	Ra-226	6.09 ± 1.23	5.72 ± 1.16	1.70 ± 0.34	1.24 ± 0.25	
Total			8.47 ± 1.73	2.14 ± 0.42	1.84 ± 0.36	
S – BH	Th-232	25.55 ± 5.76	23.50 ± 5.30	2.59 ± 0.58	4.29 ± 0.97	895.00±192.00
	K-40	558.82 ± 31.69	6.93 ± 0.40	2.54 ± 0.14	2.53 ± 0.14	
	Ra-226	54.18 ± 13.34	50.90 ± 12.50	15.20 ± 3.73	11.10 ± 2.73	
Total			81.40 ± 18.20	20.30 ± 4.46	17.90 ± 3.84	
Q – BH	Th-232	2.53 ± 0.90	2.33 ± 0.83	0.26 ± 0.10	0.43 ± 0.15	91.40 ± 22.00
	K-40	61.64 ± 3.74	0.76 ± 0.05	0.28 ± 0.02	0.28 ± 0.02	
	Ra-226	5.50 ± 1.33	5.17 ± 1.25	1.54 ± 0.37	1.12 ± 0.27	
Total			8.27 ± 2.12	2.08 ± 0.48	1.83 ± 0.44	
M – BH	Th-232	1.66 ± 0.46	1.52 ± 0.42	0.17 ± 0.05	0.28 ± 0.08	73.40 ± 15.60
	K-40	41.96 ± 3.07	0.52 ± 0.04	0.19 ± 0.01	0.19 ±0.01	
	Ra-226	4.90 ± 1.08	4.60 ± 1.02	1.37 ± 0.30	1.00 ± 0.21	
Total			6.65 ± 1.48	1.73 ± 0.36	1.47 ± 0.31	

Sampl	Activity concentration Bql^{-1}	Annual Eff dose (0-1yrs) mSvy^{-1}	Annual Eff dose (7-12yrs) mSvy^{-1}	Annual Eff dose (>17yrs) mSvy^{-1}	Committed eff dose (>17yrs) mSvy^{-1}
H - BH	2.77 ± 0.21	2.55 ± 0.20	0.28 ± 0.02	0.47 ± 0.04	
	53.95 ± 3.43	0.67 ± 0.04	0.25 ± 0.02	0.24 ± 0.02	
	8.08 ± 1.59	7.60 ±1.49	2.26 ± 0.44	1.65 ± 0.32	
Total		10.80 ± 1.73	2.79 ± 0.48	2.36 ± 0.38	**118.00 ± 18.80**
E - BH	2.88 ± 0.53	2.65 ± 0.49	0.29 ± 0.05	0.48 ± 0.09	
	45.42 ± 2.98	0.56 ± 0.04	0.21 ± 0.01	0.21 ± 0.01	
	7.78 ± 1.33	7.32 ± 1.25	2.18 ± 0.37	1.59 ± 0.27	
Total		10.50 ± 1.77	2.68 ± 0.44	2.28 ± 0.37	**114.00 ± 18.70**
K - BH	35.61 ± 6.22	32.80 ± 5.72	3.61 ± 0.63	5.98 ± 1.04	
	467.61 ± 31.69	5.80 ± 0.39	2.13 ± 0.14	2.12 ± 0.14	
	56.68 ± 12.50	53.30±11.80	15.90±3.50	11.60 ±2.56	
Total		91.80±17.90	21.60±4.28	19.70 ±3.74	**984.00 ±187.00**
A - BH	3.55 ± 0.74	3.30 ± 0.68	0.36 ± 0.08	3.37 ± 1.15	
	73.13 ± 4.22	0.91 ± 0.05	0.34 ± 0.02	1.27 ± 0.08	
	7.08 ± 1.71	6.65 ± 1.61	1.99 ± 0.48	1.45 ±0.35	
Total		10.86 ± 2.34	2.69 ± 0.58	6.09 ± 1.58	**304.00 ± 79.00**
I – BH	2.25 ± 0.39	2.07 ± 0.36	0.23 ± 0.04	0.38 ± 0.07	
	64.81 ± 3.07	0.80 ± 0.04	0.30 ± 0.01	0.29 ± 0.01	
	8.25 ± 1.50	7.76 ± 1.41	2.31 ± 0.42	1.69 ± 0.31	
Total		**10.60 ± 1.81**	**2.83 ± 0.47**	**2.36 ± 0.39**	**118.00 ± 19.30**

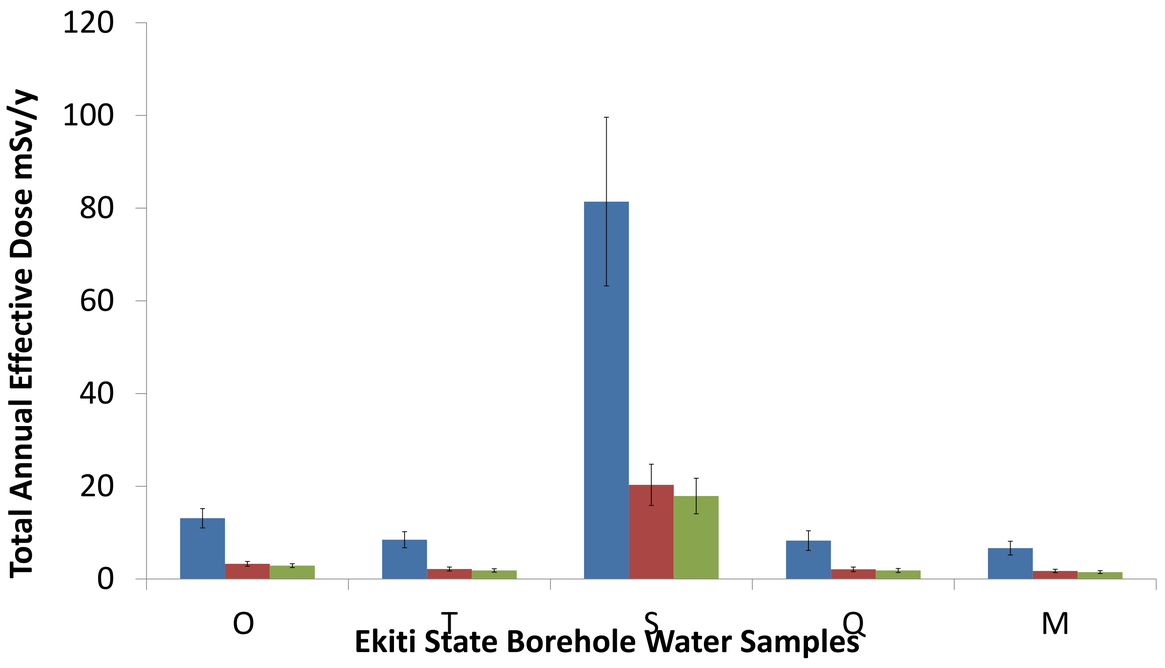

Figure 1.0: Total annual Effective Dose D (Sv/yr) variation in the dug well water samples of Ekiti State

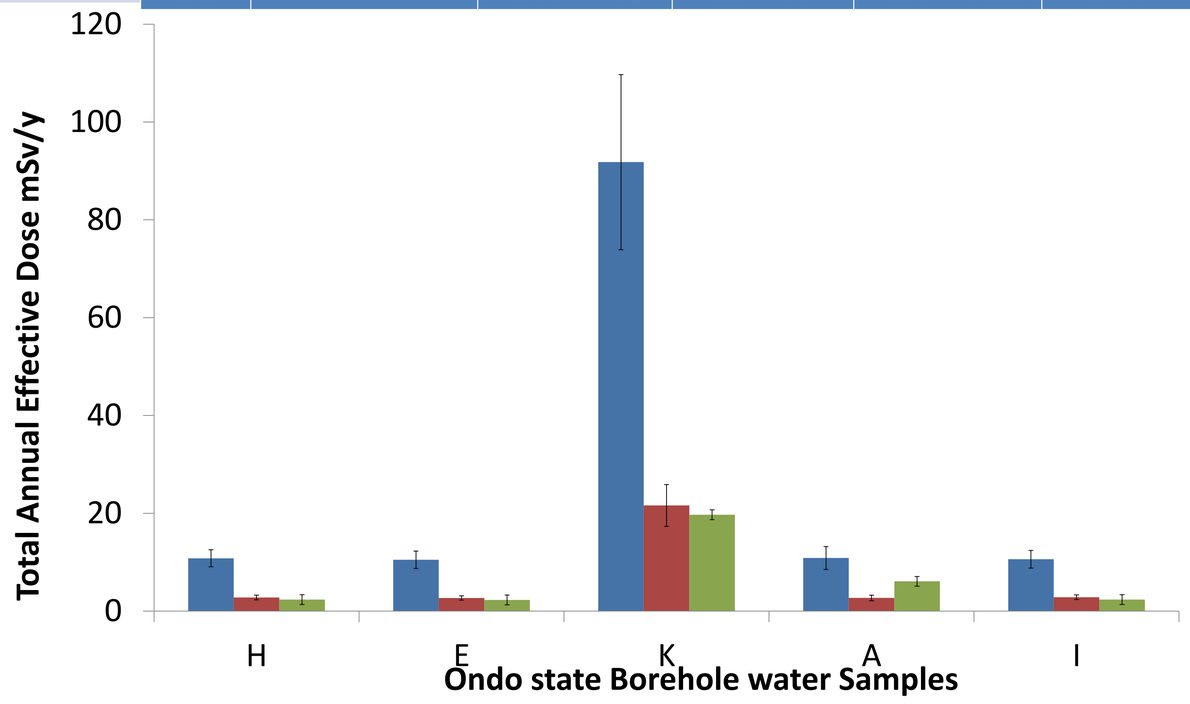

Figure 2.0: Total annual Effective Dose (Sv/yr) in the dug well water Samples of Ondo State

CONCLUSION

The activity concentrations of ^{232}Th, ^{40}K, and ^{226}Ra in the dug well water samples distributed across ten (10) notable Cities in Ondo and Ekiti States were determined. The activity concentration of gamma emitters in the drilled well water ranged from 2.25 0.39 to 35.61 6.22 Bq l^{-1} ^{232}Th, 45.42 2.98 to 467.61 31.69 Bq l^{-1} ^{40}K, 7.08 1.71 to 56.68 12.50 Bq l^{-1} ^{226}Ra and 1.66 0.46 to 25.55 5.76 Bq l^{-1} ^{232}Th, 41.50 2.89 to 558.82 31.69 Bq l^{-1} ^{40}K, 4.90 1.08 to 54.18 13.34 Bq l^{-1} ^{226}Ra respectively for Ondo and Ekiti states. The age dependent total annual effective dose due to the ingestion of these radionuclides from the drilled well of Ondo and Ekiti States was found to be above the recommended limits of 1.0 mSv/y and 0.1 mSv y^{-1} set by ICRP and WHO respectively for the samples taken from Erinmope Ekiti and Ikare-Akoko.

Hence the affected drilled are recommended for screening for radionuclides to prevent the outbreak of radiation induced diseases. In all the samples considered across the two states, Babies were most susceptible to radiation followed by Children and the least was Adult.

SOME REFERENCES

[1] Akinloye, M. K. (2008); Radioactivity in LAUTECH Water Supplies, Nigeria Nigerian Journal of Physics 20 (1), 29-37.
[2] NCRPM (National Council on Radiation Protection and Measurement)., (1996): Screening Models for releases of radionuclides to atmosphere, surface water and ground. Report 123 (Bethesda, MD: NCRP Press).
[3] Mays, C.W., Rowland, R.E. and stehney, A.E., (1985). Cancer risk from the lifetime intake of Ra and U isotopes. Health Phys. 48(5), 635 – 647
[4] Guogang J, Giancarlo T, Leandro (2009). Concentrations of ^{238}U, ^{234}U, ^{235}U, ^{232}Th, ^{230}Th, ^{228}Th, ^{226}Ra, ^{228}Ra, ^{224}Ra, ^{210}Po, ^{210}Pb, and ^{212}Pb, in Drinking water in Italy: Reconciling Safety Standards Based on Measurements of gross α and β. J Environ. Rad., 100:941-949