THE ASSESSEMENT OF NATURAL RADIONUCLIDES FROM WATER SAMPLES CONSUMED IN YABA- TECH AREA OF LAGOS STATE.

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ABSTRACT

Water which is one of the most indispensable and precious natural resources is expected to be free from pollution and therefore should be given highest priority in terms of environmental contaminations. The assessment of natural radionuclide concentrations of samples from Yaba College of Technology and the environs were conducted using sodium iodide detector in this research. Thirty samples of both sachet and bottled water samples were collected and analyzed. The results show that the activity concentrations of Radium (^{226}Ra), ranged from 8.49 ± 4.59 to 26.25 ± 3.99,with the mean value of 12.93±3.10, the activity concentrations of Thorium (^{232}Th) also ranged from 6.09± 3.01 to 25.14± 1.00 while potassium (^{40}K) activity concentrations values ranged from 101.18 ±45.75 to 315.34 ±38.00. The result shows that the absorbed dose rate and the annual effective dose were lower than the global acceptable values. In order words, all the sachet and bottled water sold in Yaba College of Technology are safe for drinking according to the recommendation by the regulatory bodies. Thus, the contribution from these radionuclides does not pose any significant radiological health problem to the consumers.

Keywords: Assessment, natural, concentration, bottled, radionuclide, absorbed}. Corresponding author: ayorinde12@yahoo.com.

INTRODUCTION

Water is a geologic material and has been an essential necessity of life. It is a major constituent of the human body and the environment. It is used for various purposes ranging from agriculture to industrial power generation and domestic consumption etc. Natural radio nuclides can enter the human body through ingestion of water and food. The occurrence of natural radionuclides in drinking water poses a problem of health hazard, when these radionuclides are taken to the body by ingestion (Meltem. and Gursel 2010). Radionuclides in drinking water causes human internal exposure, caused by the decay of radionuclides taken into the body through ingestion indirectly when they are incorporated as part of the human food chain (Malanca et al,.1998). Their presence in water is determined by their concentration in bedrock. It has been noted that radiation is part of the natural environment and it is estimated that approximately 80% of all human exposure comes from naturally occurring radioactive materials (Ahmed et al., 2014).

Measuring the levels of natural and artificial radiation in the environment is crucial in implementing appropriate controls for the sake of radiological protection (Kinyua et al., 2011). The increasing consumption of these portable water by people of all ages – infants, children and adult alike – calls for evaluation of its suitability for consumption since its quality varies from source to source. Depending on the origin of groundwater, it might have high amount of the primordial radionuclide or radioactive elements such as uranium, thorium, potassium, and their radioactive decay products (UNSCEAR., (1988), Amurani., (2002). Montero et al. (1999)) stated that the radiological safeguards of drinking water are based on the control of natural and anthropogenic radionuclide concentration.

According to Forte et al. (2007) both ground and freshwater usually contain variety of radionuclides with the freshwater usually exposed to artificial radionuclide contamination as a result of radioactive fallouts. Ibrahim et al., (2011) suggested that groundwater in some parts of Yemen are not safe to be used as drinking water due to their higher activity concentrations of ^{226}Ra and^{232}Th.They further concluded that high activity concentrations for ^{226}Ra and^{232}Th in groundwater points to high activity levels in aquifer rocks which establishes a strong relationship between groundwater and bedrock with regards to radionuclide contamination.

Through this study, adequate data on natural radionuclide concentrations will be established. This will help in assessing any possible radiological hazard that the Yaba College Of Technologh staff and students could be exposed. Such a detailed baseline data will be made available to guide all stakeholders involved in the monitoring of the environment for environmental pollutants including radiation exposure.

EXPERIMENTAL PROCEDURE

Study area

The study area, Yaba College of Technology is situated in the central part of Lagos state. The College is densely populated with many offices, commercial and industrial activities going on within the premises and environs.

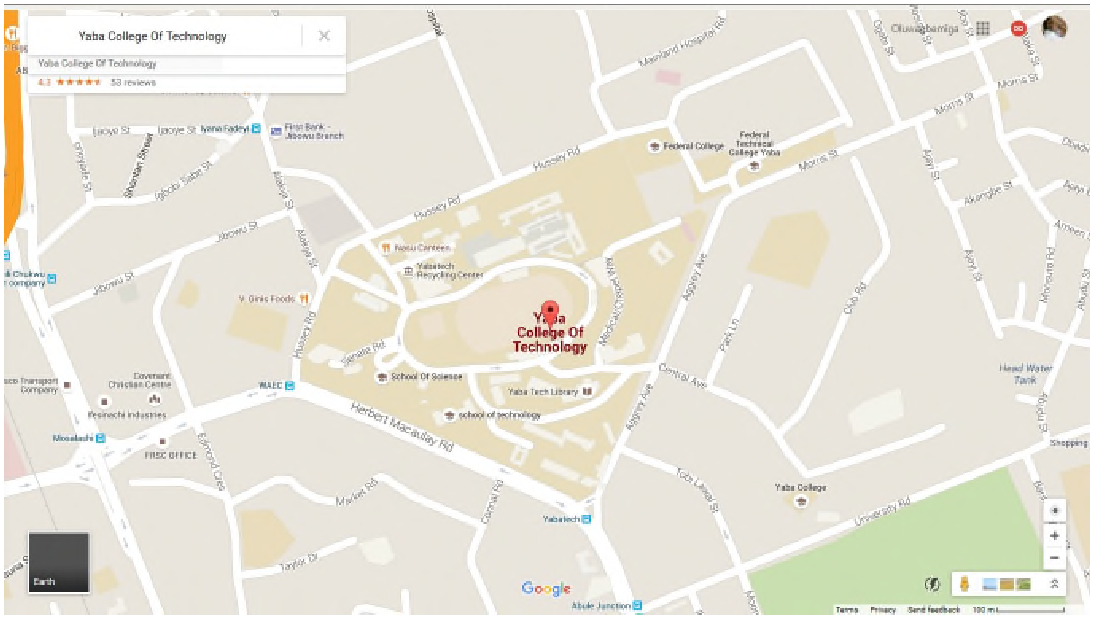

Fig 1. Map of Lagos showing Yaba College of Technology

Water Sample Preparation.

Two samples per brand of ten different bottled water samples, making a total of 20 samples and ten different sachet water, altogether 30 samples of package water were bought from their different retailer in Yaba college of Technology, Yaba Lagos Nigeria. Samples were later transported to the processing laboratory of the department of Pure and Applied Physics of Ladoke Akintola University, Ogbomoso Nigeria. At the laboratory, Marinelli type beakers (2 litre in capacity) were used to process and measure the water samples. The beakers were made contamination-free by cleaning them well using light hydrochloric acid solution and de-ionized water. The beakers were then dried using a temperature-controlled oven and filled with appropriate amount of water sample. Finally, the sample-filled beakers were closed by caps, wrapped with thick vinyl tape around their necks and kept for four weeks to achieve the secular equilibrium between gaseous and non-gaseous decay products of naturally occurring radionuclide series. The samples were then analyzed using Sodium Iodide detector.

Instrumentation.

Using a well calibrated Sodium Iodide Detector NaI (TI) and well shielded detector couple to a computer resident model quantum MCA2100R Multichannel analyzer, each sample was counted for 36,000s (10hrs). An empty container under identical geometry was also counted for the same time. The 1460KeV gamma-radiation of ^{40}K was used to determine the concentration of ^{40}K in the sample. The gamma transition energy of 1764.5KeV ^{214}Bi was used to determine the concentration of ^{238}U while the gamma transition energy of 2614KeV ^{208}TI was used to determine the concentration of ^{232}Th and ^{137}Cs was detected by its 661.6KeV gamma transition. The efficiency calibration of the detector was done using a reference standard mixed source traceable to Analytical Quality Control Service (AQCS, USA), which has certified activities of the selected radionuclides and has a geometrical configuration identical to sample container. The standard sources contain ten known radionulide.The energy calibration was also performed by using the peaks of the radionuclide present in the standard sources. The channel number is proportional to energy; the channel scale was then converted to an energy scale. This produces an energy calibration curve, i.e. energy versus channel.

RESULTS AND DISCUSSION.

The measured activity concentration of^{226}Ra, ^{232}Thand ^{40}K in the water samples are presented in table1 below.

Samples	K-40	Ra-226	Th-232
1	315.43±38.00	17.43±3.19	12.03±5.16
2	201.18±45.75	18.25±3.99	10.88±2.65
3	104.16±70.01	9.19±3.01	7.83±2.08
4	135.60±35.55	8.49±4.59	6.09±3.01
5	125.16±45.77	10.04±3.38	6.54±3.64
6	104.16±70.01	26.25±3.99	12.03±5.16
7	109.36±2.70	16.92±3.00	10.06±1.40
8	142.31±1.40	10.06±1.90	15.44±2.30
9	312.44±3.20	11.14±2.20	15.45±1.20
10	210.62±3.90	14.50±1.70	15.14±1.00
11	115.43±38.00	17.43±3.19	12.03±5.16
12	101.18±45.75	13.25±3.99	10.88±2.65
13	204.16±70.01	9.19±3.01	17.83±2.08
14	135.60±35.55	8.49±4.59	6.09±3.01
15	125.16±45.77	10.04±3.38	6.54±3.64
16	109.36±2.70	12.92±3.00	14.06±1.40
17	242.31±1.40	10.06±1.90	15.44±2.30
18	112.44±3.20	12.14±2.20	11.45±1.20
19	210.62±3.90	24.50±1.70	25.14±1.00
20	101.18±45.75	11.25±3.99	10.88±2.65
21	215.43±38.00	17.43±3.19	12.03±5.16
22	101.18±45.75	11.25±3.99	10.88±2.65
23	204.16±70.01	9.19±3.01	17.83±2.08
24	236.60±35.55	8.49±4.59	6.09±3.01
25	125.16±45.77	10.04±3.38	6.54±3.64
26	104.16±70.01	12.25±3.99	11.03±5.16
27	109.36±2.70	1.92+3.00	12.06±1.40
28	142.31±1.40	10.06±1.90	11.44±2.30
29	312.44±3.20	11.14±2.20	12.45±1.20
30	110.62±3.90	14.50±1.70	15.14±1.00
Mean	162.64±30.82	12.93± 3.10	11.91± 2.68
Std	67.44±25.10	4.42±0.90	4.17 ±1.36

Table 1. Results of activity concentration in drinking water samples. The activity concentration of ^{226}Ra, ^{232}Th and ^{40}K ranged from 8.49 to 26.25Bq/kg , 6.09 to 25.14Bq/kg and 101.18 to 315.64Bq/kg respectively. Sample 6 had the highest activity concentration of ^{226}Ra while samples 4, 14, 24 had the lowest activity concentration. The highest activity concentration for ^{232}Th was found in sample 19 while the lowest activity concentrations were found in samples 4, 14 and 24. Samples 1,9 and 29 had the highest activity concentration of ^{40}K and samples 12, 20 and 22 had the lowest activity concentration. All the Samples analysed in this present research satisfy the safety criterion. Hence ,the samples under consideration does not pose any health hazard to the consumers.

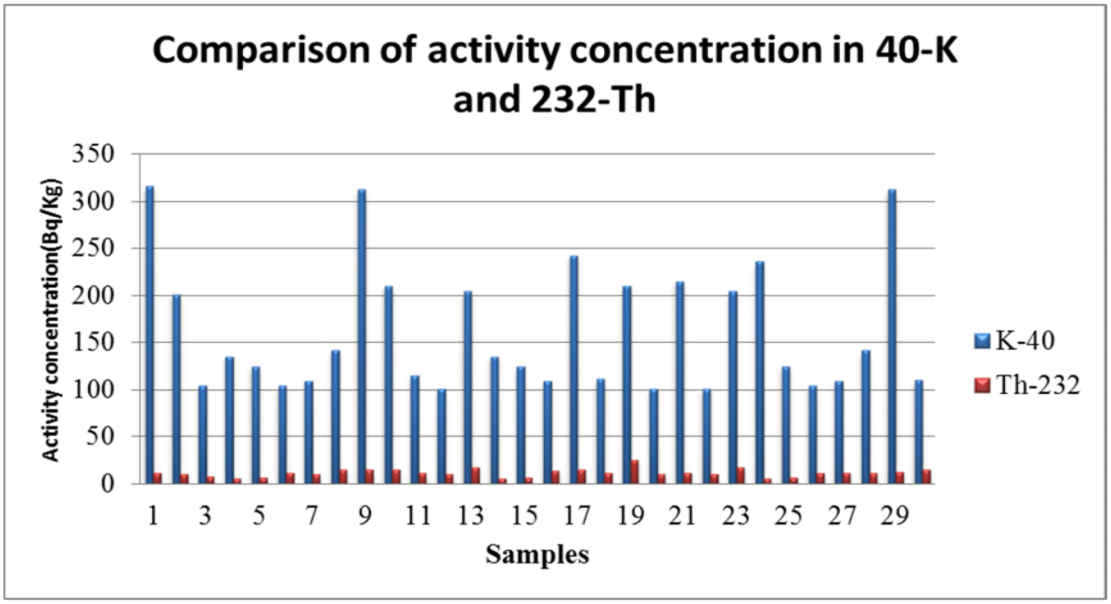

Fig.1 Activity concentration of ^{40}K and ^{232}Th in Potable water.

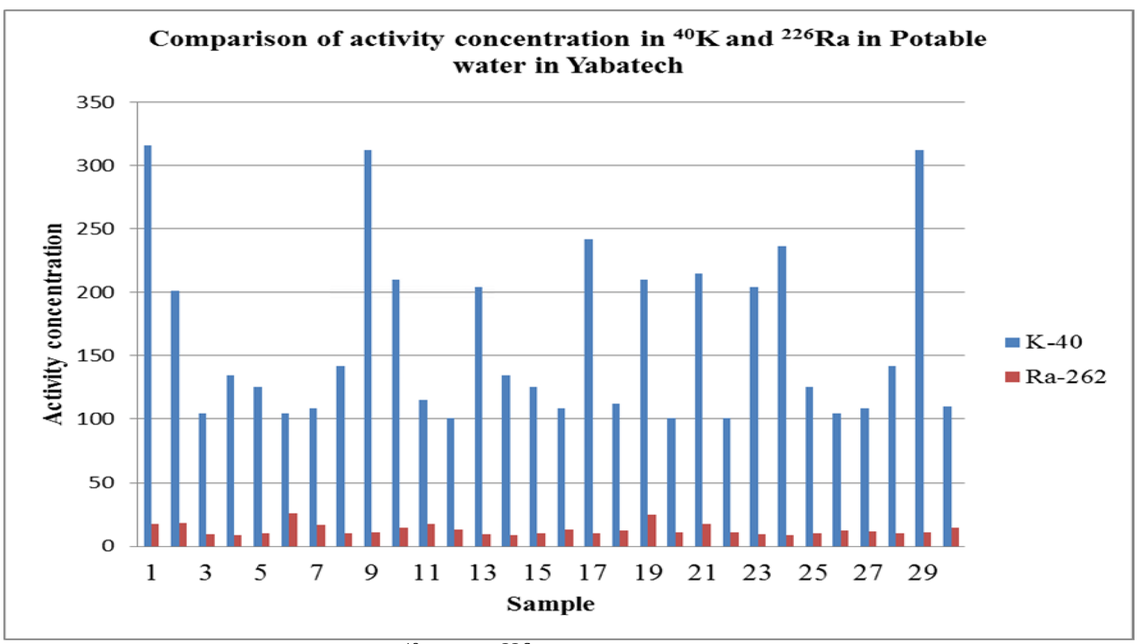

Fig.2 Activity concentration of ^{40}K and ^{226} Ra in Potable water.

Radium Equivalent Activity (Ra eq):

For the purpose of comparing the radiological effect or activity of materials that contain^{226}Ra, ^{232}Th and ^{40}K by a single quantity, which takes into account the radiation hazards associated with them, a common index termed the radium equivalent activity (Raeq) is used. This activity index provides a useful guideline in regulating the safety standards on radiation protection for the general public residing in the area under investigation.

The Raeq index $\{\mathbf{Raeq}\} = \mathbf{A_{Ra} + 1.43A_{Th} + 0.077A_K}$ ------ 1

Where A_{Ra} ,A_{Th} and A_k are the activity concentrations {Bq/kg}of ^{226}Ra, ^{232}Th and ^{40}K respectively in the samples. The calculated Raeq was 42.48 $Bqkg^{-1}$.This value is less than the world acceptable value of 370$Bqkg^{-1}$.

Estimation of absorbed dose rate (D):
In order to provide a characteristic of the external gamma –ray, the absorbed dose rate D in air at 1 m above the ground (in $nGyh^{-1}$) was calculated using the equation below (UNSCEAR, 2000, Veiga et al.,2006) i.e

$$\mathbf{D\ (nGy\ h^{-1}) = 0.0417A_K + 0.462A_{Ra} + 0.604A_{Th}} \quad \text{-----}\quad 2$$

Where A_{Ra} ,A_{Th} and A_k have their usual meaning as in equation 1.The absorbed dose value calculated in this work has the value 19.94 nGy / h . The Absorbed dose calculated is lower than the world average of 55 nGy h^{-1}.

In natural environmental radioactivity situations, the effective dose is calculated from the absorbed dose by applying the factor 0.7 Sv/Gy (UNSCEAR, 1993) and outdoor occupancy factor 0.2

$$\mathbf{Effective\ dose\ rate\ (\mu Sv\ yr^{-1}) = D\ (nGyh^{-1})\ x\ 8760\ h\ x\ 0.2\ x\ 0.7\ Sv\ Gy^{-1}\ x\ 10^{-3})} \quad \text{-----}\quad 3$$

The Effective dose rate obtained was 24.45 ($\mu Sv\ yr^{-1}$).

Estimation of annual Gonadal Equivalent Dose (AGED)

The gonads ,bone marrow and bone surface cells are considered as organs of interest by UNSCEAR (1988) because they are the most sensitive parts of human body to radiation. An increase in AGED has been known to affect the bone marrow. This situation results in blood cancer (leukemia). AGED is calculated with activity concentrations ^{226}Ra, ^{232}Th and ^{40}K. (Bq /kg) using this relation:

$$\mathbf{AGED\ (mSv\ /yr) = 3.09A_{Ra} + 4.18A_{Th} + 0.314A_K}$$

Where.A_{Ra}, A_{Th} and A_K the are activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K. (Bq /kg) in water samples respectively. The calculated AGED result was 140.807 (mSv /yr) .

CONCLUSION.

The radionuclide contents, activity concentrations and radiological impact of the sachet and bottled water samples sold from the food village in Yaba College of Technology, Yaba Lagos state and its environs were investigated by means of Sodium Iodide Detector in the present study. A total of Thirty samples were collected and analysed. The results indicated that natural radionuclides were present in the samples. The natural radioactivity concentrations of ^{226}Ra, ^{232}Thand ^{40}K were relatively lower than the world average values. The mean values of absorbed dose rate, annual effective dose and the radium equivalent activity were lower than the global average values. In order words all sachet and bottled water sold in Yaba College of Technology are very safe for drinking according to UNSCEAR standards.

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