EVALUATION OF INDOOR GAMMA RADIATION ABSORBED DOSE IN SELECTED BUILDINGS WITHIN YABA COLLEGE OF TECHNOLOGY

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ABSTRACT
This research was conducted to measure the rate of exposure of radiation in some selected buildings in Yaba College of Technology and determine whether it is within a tolerable limit recommended by standard bodies. Indoor gamma radiation measurement was carried out in five new buildings within Yaba College of Technology with a nuclear radiation monitor (PRM 9000) calibrated in microsievert per hour (µSv/h) . The device was placed at 100 cm above the ground level for effective detection. The mean readings of the values taken at each of the five different sampling locations for ten minutes was recorded for each of the locations. The results showed that the mean absorbed dose rate ranges from 0.107µSv/h to 0.120µSv/h while annual absorbed dose rates obtained was 588.672±49.06 mSv/yr, 539.62 mSv/yr, 588.672±84.97 mSv/yr, 588.672±49.06 mSv/yr and 523.264±28.32 mSv/yr for New Building, New Food Technology Building, Multipurpose Building, Seven-Storey Building and Bursary/Registry respectively. The values obtained in all the locations were lower than 1mSv/yr and 2.4 mSv/yr, the recommended standards of the International Commission for Radiation Protection (ICRP, 1990) and United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR, 2000) respectively. The result of the present study showed that the users of these buildings were exposed to insignificant radiation effects.

Keywords: Indoor, Absorbed Dose, Buildings, Gamma, Radiation.

1.0 INTRODUCTION
Radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium (Weisstein, 2007). Non-ionizing radiation is a form of radiation that has enough energy to move atoms in a molecule or cause them to vibrate but not enough to remove electrons (USEPA, 2013). Example includes Low frequency, Ultraviolet ray, Infrared, Microwave, thermal (heat) blackbody radiation. These types of non-ionizing radiations are not considered to pose a health risk. Ionizing radiation is a radiation with enough energy so that during an interaction with an atom, it can remove a tightly bound electron from the orbit of an atom causing the atom to be changed or ionized (World Health Organization (WHO), 2014).

Background radiation is the ionizing radiation that surrounds us at all times. Everyone on earth is exposed to background radiation. Exposures to background radiations could be from either natural or artificial sources. Natural source come from the atmosphere, as a result of radiation from outer space, the earth and even radiations from human body as a result radionuclides the food, water and the air we breathe. Artificial radiations are made available to our environment from consumer products, nuclear power plants and medical procedures. The largest source of man-made
radiation exposure or dose is from medical testing and treatment (NCRP, 2009).
Naturally occurring radionuclides are ever present in various degrees in all forms in our environment. In this same vein, building materials in use today contain various concentrations of radionuclides components that contribute to the indoor ambient radiation levels. Building materials are one of the potential sources of radioactivity, imparting external as well as internal dose to human beings.

The Environmental substances on earth contains radioactive nuclide, whose radiation level will not harm human health but when exposed to a very high dose irradiation or a longer period in higher radioactive level environment, people’s health will be affected.

Sadiq and Agba (2012), in a related study, evaluated for indoor and outdoor radiation absorbed dose in some selected areas in Keffi, Nasarawa State, Nigeria. The indoor and outdoor radiation levels were inspected using a halogen-quenched GM detector (US made inspector Alert Nuclear Radiation monitor SN: 35440). For indoor measurements, buildings like churches, mosques and houses were used. The monitor was held at 100cm above the ground level throughout the study with equivalent dose of microsievert per hour (µSv/h) was the measurement in the investigated study. Several readings were taken and the mean absorbed dose rate was then calculated using the recommended standard UNSCEAR (1988) for indoor occupancy factor (OF) of 0.8 which is proportional to the total time during which an individual is exposed to a radiation field. The calculated value for outdoor highest absorbed dose was 0.250mSv/yr with the occupancy factor by UNSCEAR (1988) 0.2 was used.

Ogunremi et al., (2013) also in a related study evaluated the outdoor radiation absorbed dose in staff quarters Yaba College of Technology using a radiation dosimeter (Lk 3600) calibrated in millisievert per hour (mSv/hr). The reading was taken from 25 different locations and 20cm and 100cm above the ground level measurement was observed. The annual absorbed dose was calculated using the occupancy factor of 0.2 and correlation coefficient of 0.7 for Adult and time taken of 8760hr/yr. The highest annual absorbed dose was then found to be 0.445mSv/yr for 20cm 0.355mSv/yr for 100cm respectively. This in a nutshell, shows that the occupancy factor for indoor radiation is greater than that of the outdoor radiation.

Osvaldo et al. (unknown date), in Cuba, also assessed the indoor gamma radiation dose in concrete buildings with a portable Reuter Stokes Environmental Radiation monitor (RSS-112) ionizing chamber, he also took his measurements at 100cm above the ground level at the center of the room. The external exposure arising indoors was estimated adopting the coefficient of 0.7Sv/Gy recommended by UNSCEAR to convert the gamma absorbed dose rate into effective dose with an occupancy factor of 0.8. He found the highest indoor absorbed dose rate to be 0.400mSv/yr.

This report is important in the sense that it will further create more awareness on exposure of sources of background radiation and possible health effect. The present study was carried out covering only the spectrum of possible radiation emission from the buildings which is a form of ionizing radiation. The evaluation of indoor radiation and distribution of absorbed dose of the selected buildings was carried out using a nuclear radiation monitor (PRM 9000) for a distance of 100cm above the ground level. The aim of this report was to measure the rate of exposure of radiation in some selected buildings in Yaba College of Technology and to determine whether it is
within a tolerable limit recommended by standard bodies.

2.0 MATERIALS AND METHOD
The indoor radiations of the selected buildings in Yaba College of Technology (6.5193°N, 3.3720°E) were taken using a radiation detecting device: Nuclear Radiation monitor (PRM 9000) calibrated in microsievert per hour (µSv/h) using a meter rule. The device was placed at 100cm above the ground level for effective detection. Three readings were taken at each of the five different sampling locations. The detector was switched on to absorb radiation for ten minutes counting downward from ten minutes to zero (0) minutes, the stable value shown at zero (0) minute on the screen was recorded for that particular location. The procedure was repeated at each location for three consecutive times and three readings in microsievert per hour (µSv/h) were recorded at each location in which the average values in microsievert per hour (µSv/h) were determined at each location.

The absorbed dose rate in mSv/yr was calculated using the expression:

\[ D = \frac{T}{\mu} \cdot Cc \cdot \sqrt{\sigma} \]  

\[ \sigma = \text{Absorbed dose rate in } \mu\text{Sv/hr} \]  
\[ T = \text{Time in hours (8760 hours for a year)} \]  
\[ D = \text{Annual absorbed dose rate in mSv/yr} \]  
\[ \mu = \text{Occupancy factor (0.8 for indoor).} \]  
\[ Cc = \text{Conversion coefficient (0.7 for adult)} \]  

(Ogunremi et al., 2013)

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**Figure 1:** Map Showing the Study Area of Selected Buildings in Yaba College of Technology.
3.0 RESULTS
The values absorbed dose rates obtained using the radiation measuring device (PRM - 9000) Nuclear radiation monitor and that of annual absorbed dose rates calculated using equation 1 above are shown in table 1 below. The mean absorbed dose rates for the selected buildings were calculated and illustrated in fig. 4 while the annual absorbed dose rates and the comparison with referenced standard value are illustrated in fig. 5 and fig. 6 respectively.

Table 1: The Mean Absorbed Dose Rates and Annual Absorbed Dose Rates for the Selected Buildings.

<table>
<thead>
<tr>
<th>Selected Buildings</th>
<th>Absorbed Dose Rates (µSv/hr)</th>
<th>Annual Absorbed Dose Rates (mSv/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Reading</td>
<td>Second Reading</td>
</tr>
<tr>
<td>New Building</td>
<td>0.11</td>
<td>0.13</td>
</tr>
<tr>
<td>New Food Tech Building</td>
<td>0.11</td>
<td>0.11</td>
</tr>
<tr>
<td>Multipurpose Building</td>
<td>0.13</td>
<td>0.13</td>
</tr>
<tr>
<td>7-Storey Building</td>
<td>0.12</td>
<td>0.11</td>
</tr>
<tr>
<td>Bursary-Registry</td>
<td>0.1</td>
<td>0.11</td>
</tr>
</tbody>
</table>
Figure 4: Mean Absorbed dose Rates (µSv/hr) at 100 cm above ground level of selected locations

Figure 5: Annual Absorbed Dose Rates (mSv/yr) of Selected Building.
3.0 DISCUSSION

It was observed from the results that the highest mean absorbed dose rates in an hour were recorded in three different locations; The Seven-Storey Building, Multi-purpose Hall and the New Building respectively for 100cm above the ground level with the value of 0.120µSv/hr. The New Food Technology Building gave a value of 0.110µSv/hr, 91.7% of the highest absorbed dose rate while the lowest value for the mean absorbed dose rate was recorded at the Registry/Bursary Building to be 0.107µSv/hr, 89.1% of the value obtained from Multipurpose Building, Seven Storey Building and New Building, and 97.3% of the absorbed dose rate from New Food Technology Building.

The annual absorbed dose rates, which represents effective dose in a year, were calculated using the formula discussed above in equation 1. Similar results as regard the highest mean absorbed dose rates values were recorded at the Seven - Storey Building, Multi – purpose Hall and The New Building each with a value of 588.672±84.97 mSv/yr, 539.62 mSv/yr was obtained for New Food Technology Building while the lowest annual absorbed dose rate was recorded at the Registry/Bursary Building with a value of...
523.264±28.32 mSv/yr. The results show that the exposure to radiation in New Food Technology Building and Registry Building was lower by 8.1% and 10.9% respectively than the exposure to radiation in Seven - Storey Building, Multi – purpose Hall and the New Building. These results suggest that some, if not all, of the building materials of the selected locations may be radioactive including their surrounding environments. The results indicated that there is ongoing radiation activity in the selected buildings where their absorbed dose distribution varies. The results obtained from this present study was compared to that of the recommended standards (Fig.6). The annual absorbed dose rates obtained from Seven - Storey Building, Multi – purpose Hall and the New Building was about 24.5% of 2.4 mSv/yr, the maximum annual absorbed dose recommended by United Nations Scientific Committee on the effect of Atomic Radiation (UNSCEAR, 2000) and 58.9% of 1 mSv/yr recommended by the International Commission for Radiation Protection (ICRP, 1990) while the value obtained was lower than these recommended standards in New Food Technology Building and Registry Building.

CONCLUSION
This study revealed that there is ongoing radiation activity in the selected locations with un-evenly distributed adsorbed dose rates. The highest calculated annual absorbed dose rate was 0.589 mSv/yr observed in three different buildings; the Seven-Storey Building, Multipurpose Hall and New Building. This value is lower than the recommended standards of 1 mSv/yr by (ICRP), 1990 and 2.4 mSv/yr by (UNSCEAR), 2000 respectively. The implication of the result of the study is that the users of the buildings are however exposed to insignificant radiation effects. Based on the results from the present study, it is strongly recommended that this same experiment should also be carried out in Epe Campus so as to ensure that the students, lecturers and members of staff are free from harmful radiation exposure.

REFERENCES


