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Research note

Assessment of Gamma Radiation Level in Science Blocks in University of Uyo, Nigeria

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P A P E R I N F O

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A B S T R A C T

The exposure level of gamma radiation and its consequent annual dose rate from the blocks faculty of sciences University of Uyo, Nigeria were investigated. An in -situ measurements of the exposure level were conducted using Radex radiation meter model RD 1212. The mean exposure measured for the different locations within the departments ranged between 0.096 ± 0.003 µSv/h µSv/h to 0.140± 0.007 µSv/h and the corresponding calculated annual dose rate (ADR) ranged between 0.742 ± 0.021 mSv/y to 0.981± 0.049 mSv/y with department of chemistry contributing the highest value. Taking the football field as the reference site, the results show that the presence of chemicals have slightly increased the radiation level in the studied area; but not large enough for being concern as the annual dose rate is below the acceptable dose limit of 1mSv/y for the public and 20mSv/y occupational limit for personnel in the department. The area of study is new hence it is recommended that routine radiation level monitoring should be carried out for possible rise in the radiation level to be observed. For the safety, it is recommended for staff and students should spend less time indoors. The proper application of gamma rays are used for sterilization and cancer therapy.

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INTRODUCTION[1]

Ionizing radiation is known to exist everywhere in our environment and has been in existence since the formation of the earth. The origin of this radiation is the natural occurring radioactive materials (NORM) in the earth crust, rocks, soils, plants, water and air [1]. Man is commonly exposed to this ionizing radiation through his interaction with the environment while these ionizing radiations are brought to the terrestrial environment through human activities within the environment. It is common knowledge that these radiations could cause injuries and malfunctioning of the human body when the radionuclide is inhaled, ingested or during body physical contact [2]. Detection and control of radiation may protect environment and creatures existing on the earth. This gamma radiation could be measured indoors and outdoors [3]. Outdoor radiations are measured outside shelters, it could be at dumpsites [4] at quarry sites [5] and in building material shops [3]. However there is evidence of existence of gamma radiation within shelters (indoors) which could be from the building materials used in the construction of the shelter, even the coal ash used as additives in the production of cement and concrete also radiates gamma radiation [3]. Gamma radiation could also radiates from books inside the rooms [6] and even stable food consumed [3]. In addition there are studies elsewhere which shows the presence of an appreciable dose of ionizing radiation in our campuses [7, 8] and one of the chief sources of this radiation is our sciences laboratories [9]. Suitable application of gamma ray may be used for sterilization of medical equipment and used for the purpose of autoclaving. In addition, gamma rays are also used to treat some types of cancer. Gamma rays may possess high energy; due to emission of electromagnetic radiation, the wave may cause any threat to human health.

The faculty of Sciences of the University of Uyo was moved to the permanent site of the University about four years ago. It is a three storey building that houses five different departments. Location of these departments in the blocks includes departments of Chemistry and Microbiology and laboratories in the ground floor, botany, herbarium and zoology in the first floor and Physics and part of zoology and their laboratories are

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located in the second floor. The faculty of Sciences in the University of Uyo is located in a new environment hence no previous radiation measurement has been carried out; therefore this work may act as a baseline data for the faculty to help detect any rise in the radiation levels in the blocks and if necessary possible regulatory control could be put in place for the safety of the students, staff and the public.

Material and Methods

Measurement of the indoor and outdoor gamma radiation level was carried out using Radex (RD 1212) radiation survey meter which measured radiation absorbed dose rate in micro Seviert per hour (μSv/h). The meter was switched on and allowed to absorb radiation for a few seconds and the meter read at the highest stable point. For effective monitoring, the radiation meter was placed at 1m above ground level with the window of the meter directed towards the different directions within the measured environment and 10 readings taken in different directions in each room and the mean recorded. Measurements were taken in the afternoon between the hours of 1pm and 4pm for effective response of the meter to environmental radiation exposures according to the method developed by Inyang et al. [10].
The exposure (σ) measured in μSv/h could be converted to annual absorbed dose rate ADR in mSv/y according to reported mathematical relationship given below [9]

$$ADR(mSv/y) = \sigma \times \mu \times 24hrs \times 365.25days \times 10^{-3} \quad (1)$$

μ is the occupancy factor and the recommended indoor and outdoor occupancy factors are 0.8 and 0.2, respectively [9] which are the proportion of the total time which an individual stays indoors or outdoors.

$$ADR(mSv/y)outdoor = \sigma(\mu Sv/h) \times 0.2 \times 24hours \times 365.25days \times 10^{-3} \quad (2)$$

$$ADR(mSv/y)indoor = \sigma(\mu Sv/h) \times 0.8 \times 24hours \times 365.25days \times 10^{-3} \quad (3)$$

The standard error (SE) was obtained for each location from the relationship

$$SE = \frac{W_2 - W_1}{N} \quad (4)$$

where the numerator of equation 2 is the range of the measurements and N the number of measurements.

RESULTS AND DISCUSSION

The result of the radiation measurements obtained for the different locations are reported in Table 1. The table shows the locations, the mean of the measured exposure and the calculated mean annual absorbed dose rate and their respective standard errors (SE). The locations of measurements are coded from S1-S20. Locations within the vicinities of department of Physics are coded S1-S4, while locations within Zoology department are coded S5-S9; locations within Chemistry department are coded as S10-S13. Again S14-S17 is located along Microbiology department block and S18-S20 is along department of Botany while the dumpsite S21 and the football field S22 is outside the science blocks and are known as outdoors.

TABLE 1. Mean measured exposure and calculated annual dose rate per locations

Location code	Location description	Mean σ $\mu Sv/h$	Mean ADR mSv/y
S1	Physics laboratory 1	0.096 ± 0.003	0.673 ±0.021
S2	Physics laboratory 2	0.118 ± 0.003	0.813 ± 0.021
S3	Physics store	0.117 ± 0.004	0.820 ± 0.028
S4	Physics veranda	0.110 ± 0.003	0.193 ± 0.021
S5	Zoology laboratory 1	0.117± 0.002	0.820 ± 0.014
S6	Zoology laboratory 2	0.107 ± 0.004	0.750 ± 0.028
S7	Zoology chemical store	0.118 ± 0.003	0.813 ± 0.021
S8	Zoology veranda	0.103 ± 0.003	0.722 ± 0.021
S9	Administration block	0.106 ± 0.003	0.742 ± 0.021
S10	Chemistry research laboratory	0.112 ± 0.003	0.785 ± 0.021
S11	Chemistry laboratory 1	0.111 ± 0.005	0.778 ± 0.035
S12	Chemistry laboratory 2	0.124 ± 0.008	0.869 ± 0.056
S13	Chemistry chemical store	0.140 ± 0.007	0.981 ± 0.049
S14	Microbiology PG laboratory	0.113 ± 0.011	0.792 ± 0.077
S15	Microbiology laboratory 1	0.115 ± 0.003	0.806 ± 0.021
S16	Microbiology laboratory 2	0.116 ± 0.003	0.813 ± 0.021
S17	Resource centre	0.130 ± 0.005	0.911 ± 0.035
S18	Botany laboratory 1	0.110± 0.006	0.771 ± 0.042
S19	Botany laboratory 2	0.121 ± 0.003	0.848 ± 0.021
S20	Herbarium	0.113 ± 0.011	0.792 ± 0.077
S 21	Faculty dumpsite	0.119± 0.012	0.209± 0.021
S 22	University field	0.053± 0.011	0.093± 0.019

In Table 1 the cumulative measured exposure for all the locations in the faculty is 2.297 ± 0.071 $\mu Sv/h$ and cumulative annual dose rate of 15.014 ± 0.585 mSv/y with the highest value of 0.487 ± 0.015 $\mu Sv/h$ obtained from locations within department of chemistry and the least exposure value of 0.106 ± 0.003 μSv/h from the dean's office. Taking the football field located 20m away from the main building accommodating the blocks as a reference shows a slight increase in the radiation level due to the activities within the science blocks.

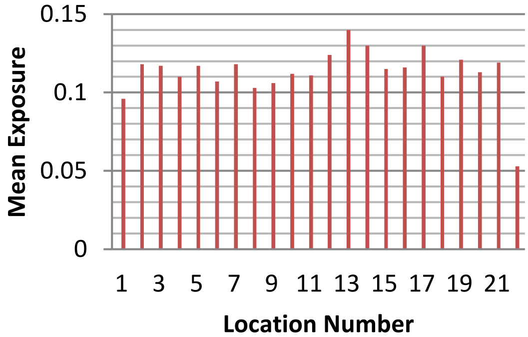

Figure 1. Mean exposure level per locations

Locations by location analysis represented in Figure 1 shows exposure ranged between 0.096 ± 0.003 μSv/h (S1) to 0.140 ± 0.007 μSv/h (S14) with the chemical stores of the departments presenting the highest exposure. The chemical store in the department of chemistry (S13) presents the highest mean exposure of 0.140 ± 0.007 μSv/h. The chemicals store in the department of zoology presented an exposure level of 0.118 ± 0.003 μSv/h while the adjacent dean's office without chemicals preserved in it presented an exposure level of 0.106 ± 0.003 μSv/h. This result is not unexpected as some of the chemicals contain element that are radioactive, for example compounds of potassium, radium, thorium and uranium are radioactive of primordial sources. The observation from the chemical store is similar to that obtained elsewhere where the reported exposure level was 0.4141 ± 0.0560 μSv/h [9]. Location S17 the resource centre also shows an appreciable exposure level of 0.130 ± 0.005 μSv/h without the presence of chemicals therefore this exposure could come from the presence of books [6] and building materials like woods [10].

The cumulative exposure level contribution from each department is presented in Figure 2 and graphically in Figure 3. Analysis of these figures shows department of chemistry contributing the highest gamma radiation level

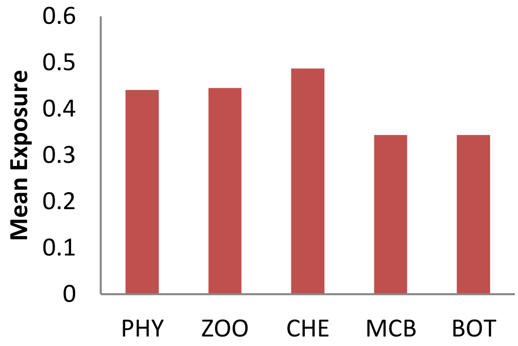

Figure 2. Cummulative mean exposure level per department

of 0.487± 0.023 μSv/h in the faculty of sciences. Other contributions include; department of Physics 0.441± 0.013 μSv/h, department of Zoology, 0.445± 0.012 μSv/h, Microbiology and botany departments were 0.344 ± 0.017 μSv/h and 0.344± 0.020 μSv/h, respectively. This shows that the chemicals in stores in the department possess a health threat to the personnel, students and the public, therefore, for the safety of the personnel and the public in the department it is precautionary that the personnel and other should spend less period a day in the chemical stores and the laboratories. Secondly, the staff and students should keep safe distance away from the chemical store especially when the chemicals are in use as the farther the staff are away from the radiation sources the lesser the dose of radiation on them because the gamma radiation obeys inverse square law of physics.

The percentage of calculated annual dose rate which expresses the amount of the radiation absorbed in air per year at the location is reported in Fig. 4. In this study chemistry department contributed 3.413 ± 0.161 (22 %)

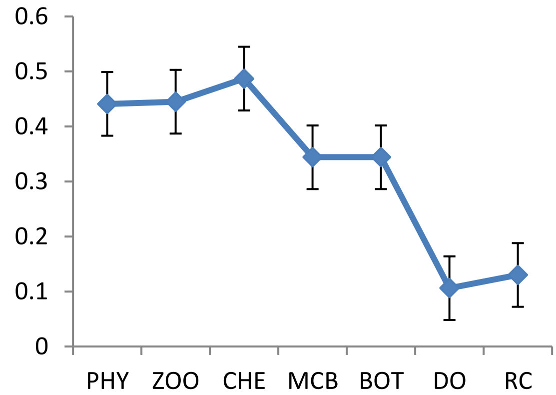

Figure 3. A graph of the mean measured exposure against departments and error bar

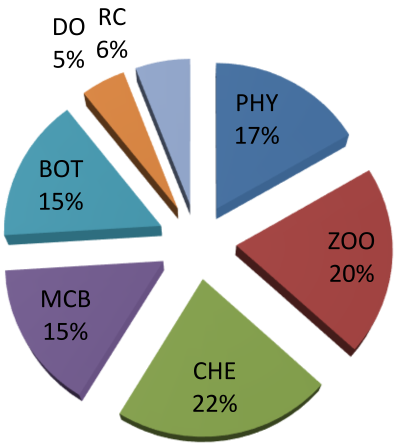

Figure 4. Annual dose rate per departments

of the total annual dose rate for the faculty of science while the dean's office contributed the least value of 0.742 ± 0.021 (5%) and resource centre contributes 0.911 ± 0.035 (6%). The calculated annual indoor background ionizing radiation for this work is obtained ranged between 0.742 ± 0.021 mSv/y to 0.981±0.049 mSv/y; this value is far less than result obtained for laboratories in University of Jos which was obtained as ranged between 2.081 mSv/y to 2.733mSv/y [8]. This remarkable difference could be because the faculty of Sciences, University of Uyo is in a new site, the permanent site hence no radiation build up in the environment of study for now.

In general the obtained cumulative annual dose rate (ADR) from all the locations in the faculty of sciences studied was 14.429 mSv/y and a mean annual dose rate of 0.751 mSv/y. These values are less than the maximum permissible natural background radiation of 1 mSv/y recommended by International Commission on Radiological Protection (ICRP-60) for the general public while the cumulative ADR is less than the ICRP -60 recommended value of 20 mSv/y for the workers. The ICRP recommended that any exposure above the recommended values should be kept as low as reasonably achievable by introducing some regulatory controls (ICRP-60). However , these values does not pose any serious health hazards to the workers and the public but there is need to look out for a possible radiation build up in future.

CONCLUSION

The result of this study shows exposure level of gamma radiation value quite close but less than the acceptable limit for safety with the department of chemistry contributing the highest. However the exposure obtained does not pose a health hazards but the staff and students should spend less time indoors in the laboratories. This area of study is a new area hence it could be recommended that routine investigation of the exposure level be carried to note any rise in the exposure for possible regulatory control to be put in place for the safety of workers and the public.

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Persian Abstract

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چکیده

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