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Measurement of background gamma radiation levels at the main campus of Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria

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ABSTRACT

An in-situ measurement of the background radiation level was carried out on the main campus of Ibrahim Badamasi Babangida University, Lapai, Nigeria. Geiger-Mueller tube-based environmental radiation dosimeter was used for the measurement. A total of 15 point was surveyed across the campus for background environmental radiation. The dose rate obtained ranged from 0.112µSv/hr to 0.210 µSv/hr. The mean dose rate was 0.158µSv/hr with standard deviation of 0.029µSv/hr. Generally, the dose rate level from different parts of the institution are comparable to one another and could simply be attributed to natural sources. The average annual effective dose obtained from this study is 0.258mSv/annum, which is less than the recommended limit of 1mSv/annum by International Commission on Radiation Protection (ICRP) for non-occupational population exposure.

Key words: Radiation, Lapai, GM tube, dose rate, minerals

INTRODUCTION

Radiation from many sources is omnipresent on earth surface, consequently man is continuously irradiated. The basic difference between ionizing radiation and other common types of radiation in the environment is that it possesses sufficient energy to cause ionization. In water of which cell are largely composed, ionization can lead to molecular changes and to the formation of chemical species of a type which are damaging to the chromosome material. Ionizing radiation injury is dependent on a number of factors including: The nature, energy, dose, time of exposure, homogeneity of dose and shielding. When the dose and the dose rate is within the accepted level, the effect of radiation is small and most time no effect is noticed, although the effect of low level radiation is not yet completely understood [6]. Human body is permanently irradiated from two ionizing radiation sources: External and internal. External radiation sources can either be natural (cosmic, earth) or artificial (e.g radiation generators), both of equal risk to man. Inside the body, the K-40 is, by its nature present throughout human life. In the case that other radionuclide such as radon in air enter the body through ingestion or inhalation, the body becomes internally contaminated.

The level of the natural radioactivity in the soil and in the surrounding environment as well as the associated external exposure due to the gamma radiation depends primarily on the geological and geographical conditions of the region [13]. The geological and geographical definition of an environment dictate to a good degree the radionuclides contained in the soil and rocks there. Soil contains small quantities of radioactive elements along with their progeny. The main sources of the external gamma radiation are from the primordial radionuclides like uranium-238, Thorium-232 and potassium-40 that are present in the earth since its formation. The amount of background radiation in an environment also depends though to a lesser extent upon man activities and soil uses. Consequently, the soil of barren area should show different amount of radioactivity when compared with that of the cultivated soil. Increased radioactivity resulting from usage of chemical fertilizers in Upper Egypt has been reported [14].

This paper presents the background radiation level and gamma absorbed dose rate to students, staffs and members of general public within the campus of Ibrahim Badamasi Babangida University, Lapai. The values obtained for background radiation from this work will form part of the baseline data for environmental radiation in Niger state of Nigeria. The background radiation level in tertiary institutions in the nearby city of Minna has been measured and was found to be above the world average [11].A study of radiation emanating from granites in an Egyptian environment has shown that in a whole body irradiation, the annual effective dose could be as much as 0.13mSv/yr[3].

MATERIALS AND METHODS

Lapai is a Local Government Area in Niger State, Nigeria, adjoining the Federal Capital Territory. It has an area of 3,051 km² and a population of 110,127 at the 2006 census. The State University was located in this city in year 2005. Since then the population has continue to increase rapidly. The university campus inhabits about 5000 people, majority of who are students who also reside in the hostels on the campuses. The town does not have any company that utilizes radioactive materials but the geology of the state suggests that environmental radiation level in the state could be significant. Niger state is covered by two major rock formations; the sedimentary and basement complex rocks. The sedimentary rocks to the south are characterized by sandstones and alluvial deposits, particularly along the Niger valley and in most parts of Borgu, Bida, Agaie, Lapai, Mokwa, Lavun, Gbako and Wushishi Local Government Area. This sub area also contains the extensive flood plains of the River Niger and this has made the state to be one of the largest and most fertile agricultural lands in the country. To the north is the basement complex, characterized by granitic outcrops or inselbergs which can be found in the vast topography of rolling landscape. Such inselbergs dominate the landscape in Rafi, Shiroro, Minna, Mariga and Gurara [1].

An in-situ measurement of the background radiation level was carried out at the Ibrahim BadamasiBabangida University, Lapaimain campus, using a portable Geiger- Mueller tube-based environmental radiation dosimeter (Digilert Nuclear Radiation Monitor, S.E. International, Inc. U.S.A). The dosimeter is exclusively designed to serve as a low level survey meter. It was calibrated with Caesium-137 gamma source. The instrument is capable of measuring gamma dose rates in the range 0 to 20mR/hr (0-0.2mSv).

RESULTS AND DISCUSSION

A total of 15 points was surveyed across the campus for background environmental radiation. The dose rate obtained at each point and the coordinates of the point is presented in table 1.

Table 1.Dose rates and their locations at the main campus of Ibrahim Badamasi Babangida University, Nigeria

Location	Coordinates		Dose rate (µSv/hr)
MMKT	9.042546N	6.340988E	0.112
HSTA	9.042065N	6.340670E	0.124
HSTB	9.042321N	6.340837E	0.138
HSTC	9.041850N	6.340914E	0.127
LBRY	9.040929N	6.341634E	0.153
CLNC	9.035881N	6.345229E	0.151
GLLB	9.040101N	6.341909E	0.171
PHLB	9.040231N	6.341978E	0.177
MRLB	9.035530N	6.341703E	0.197
BHLB	9.035425N	6.341273E	0.195
CHLB	9.035434N	6.341201E	0.204
TWTH	9.034919N	6.341576E	0.210
MCDT	9.033660N	6.344261E	0.185
PSDT	9.032839N	6.344187E	0.183
AMBK	9.033607N	6.342307E	0.166

In all the measurements, the dose rate varied from 0.112µSv/hrto 0.210 µSv/hr. The mean is 0.158µSv/hr with standard deviation of 0.029µSv/hr. Generally, the dose rate levels in each of the locations are comparable to one another and could simply be attributed to natural sources as there are no radiation generators around them. The mean dose rate of 0. 158µSv/hr obtained here is found to be roughly thrice that of the world average (0.056µSv/hr), and slightly higher than, but comparable to 0.154µSv/hr obtained in Minna, about 72 kilometres north of Lapai[11]. A larger percentage of radiation in the surveyed area is due to activities of naturally occurring radionuclides, mainly ^{226}U, ^{232}Th, and ^{40}K which have high concentrations in granites. The remaining being cosmic radiation. It can be deduced therefore that there is a large deposit of granite in the study area. A comparison with some similar work is shown in table 2.

Table 2.Comparison of dose rate from this work and other regions

Dose rate (µSv/hr)	Region	Reference
0.056	World average	[13]
0.253	Turkey	[8]
0.057	Spain	[2]
0.117	Bangalore (india)	[12]
0.132	Offa	[9]
0.134	Ilorin	[10]
0.154	Minna	[11]
0.158	This work	

The background radiation level varies from one point to other within the campus. From the extreme north of the school toward the south, the radiation level increases steadily, reaching a peak at the twin theatre lecture hall and then decreases toward the southern part of the university. The radiation level around the laboratories at faculty of science is generally higher, but this cannot be attributed to artificial sources of radiation since no radioactive material was kept in any of the laboratories. The highest value of 0.210 µSv/hr was obtained around the twin theatre lecture hall, which accommodates about 500 people and is always occupied for most of the time of the day. There is high probability that there could be mineral deposit with high radioactivity around the hall. The dose rate variation across the campus is shown in figure 1.

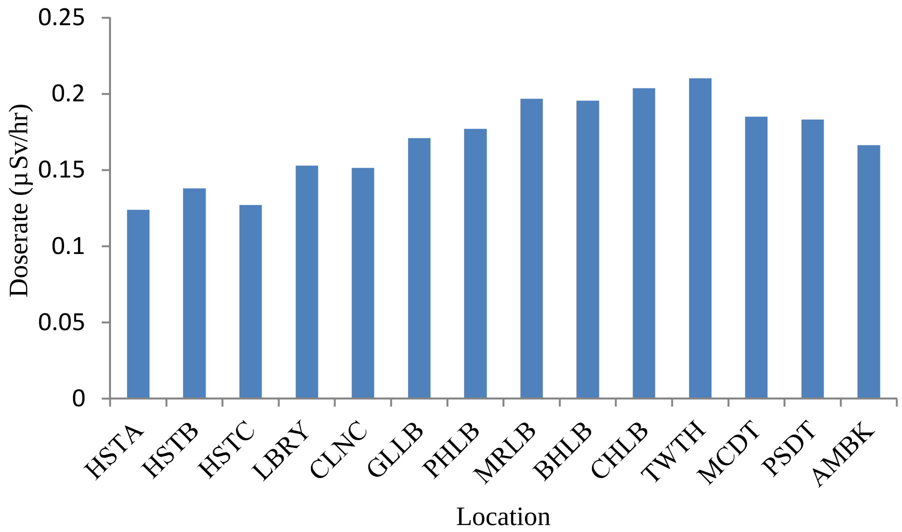

Figure1. The variation of dose rates at different locations within the main campus of IBB University, Lapai

To estimate the annual effective dose the conversion factor of 0.7 Sv/Gy was used with outdoor occupancy factor of 0.2. This indices measure the risk of stochastic and deterministic effects in the irradiated individuals. The recommended value of the annual effective dose is0.48 mSv/yr and the criterion of the total annual effective dose (indoors + outdoors) should be less than1 mSv/yr[13]. The values obtained ranged between 0.137mSv/yr and 0.258mSv/yr, with an average of 0.204mSv/yr. These values are lower than 1mSv/yr limit recommended by International Commission on Radiation Protection [6] for non-occupational population exposure.

CONCLUSION

The background radiation, which varied from one place to another on the campus, could be attributed only to natural sources (cosmic and terrestrial). The geology of the area suggests that the soil in Lapai town has a large deposit of granite. It is well known that granites contain high concentrations of uranium, thorium and potassium [7]. There is thus a need for a comprehensive radiological study of the area to ascertain the radionuclide responsible for the elevated gamma dose rates. There might be deposit of radioactive mineral around the survey areas, especially near the largest lecture hall of the university. This study has established an external dose rate to the population in Lapai. Although dose rate values obtained are higher when compared to values from other two towns in the region and global average, their effective annual dose is still lesser than the recommended dose limit.

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