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Comparative Survey of Radon-222 Level in Some Residential Houses in Barkin-Ladi Local Government Area, Plateau State, Nigeria

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Abstract: Exposure to Radon gas through inhalation can cause radiological risk. This study was carryout to ascertain the possibilities of radon gas pollution due to the inhalation of radon gas in the study area and to compare its concentration in houses built on rocks and those that are not built on rocks. The radon activity concentration were determined in some selected residents in Barkin-Ladi and environs in Barkin-Ladi Local Government Area of Plateau State where most residents were built on rocks. The concentration of ^{222}Rn was determined using Safety siren pro radon gas detector. The result show that the activity concentrations of ^{222}Rn for houses built on rock ranges from 173Bq/m^3-222Bq/m^3 and for houses not built on rock, the ^{222}Rn activity concentration ranges from 177Bq/m^3-218Bq/m^3. The values obtained when compared with the world average was found to be below the allowed limits in some communities and above the allowed limits in some of the communities. Therefore living in those communities where the radon activity concentration does not exceed the allowed limit in studied area will pose no significant radiological hazards to the residents. However, dwelling in the communities where the radon activity concentration exceeds the allowed limit in the studied area may pose slight radiological hazard to the residents.

Keywords*: Rn, activity concentration, inhalation, Hazard, human and Barki-Ladi*

I. INTRODUCTION

Exposure to radon above an acceptable limit of picocuries per liter (pci/L) of air by the environmental protection agency has proven to result in respiratory effects and cancer of the lungs. Having the knowledge that excessive inhalation of radon has effect on human, there is need to check and make sure these acceptable limits is not exceeded in Barkin-ladi and environs.

Due to lack of space for housing and ignorant of radioactivity, especially the effect of radon gas, people acquire land on rocks and build residential houses in such places. Barkin-Ladi is one of those communities in Plateau State, Nigeria whose most of the land mass is occupied by rocks.

Radon is released from rocks and penetrates materials like low density plastic, paints, papers, building materials like concrete blocks, wood paneling and most insulations and accumulates inside dwellings. Radon is an alpha particle emitter which is hazardous to the human health. The emitted alpha deposits its energy on short distance and can cause damage in human organs (Garba A.M. , 2008).

Radon particles have sufficient energy to penetrate human tissue and damaged cells. There are two ways radon daughters enter the human body; either through inhalation or ingestion. It is believed that the ingesting is not a danger in the presence of food in the stomach even thickness not exceeding 1.5 mm can stop most of alpha particles produced from the disintegration of radon and its daughters (LWRC,1986). Researchers found that the biological half-life of radon is 30 minutes when the stomach empty and 70 minutes when the stomach is filled. (Hursh,1965).

The greatest health risks come from exposure to the inhaled radon gas decay products that are produced during its radioactive decay. Two of these decay products. polonium-218 and polonium-214, present as a significant radiologic hazard. Once the radioactive decay products are inhaled into the lung, they undergo further radioactive decay, releasing small bursts of energy in the form of alpha particles that can either cause DNA breaks or create free radicals (Filed,1999).

Radon have a large half-life compared with the respiratory system , either it moves to the circulatory system, or backs out from the lung through exhaled. Disintegration product of radon attaches itself to trachea has a great potential to enter the lung and disintegrate and hurt the lung. Studies have shown that the dose received by the lung greater than 2 to 3 times, those received by the stomach due to digestion (McPherson,1980), (Crawford,1987). It has been estimated that about 6% of the cases of lung cancer in the UK can be attributed to radon (Green,1992). There are many reports pointed the biological influence of ionizing radiation that approximately 10% of cancer are as a result of radon (NRC,1988), (Durrani,1993).Although there is so far no evidence linking radon ingestion and increased cancer cases diseases (Prichard,1981).But Some studies have shown that radon can be attributed to some types of cancers such as leukemia, kidney cancer and prostate cancer (Lucie,1989).

Generally speaking, the slightly elevated radon levels normally, found in most homes is considered inconsequential or at least not more hazardous than other normally acceptable risks. A significant fraction of homes have what some authorities considered to be unacceptable levels of indoor radon (UNSCEAR,1988).

In some countries 4.0 p Ci/L (150- 200Bq/m3) is generally used as a guideline.

The intake limits are expressed in terms of potential energy resulting from the inhaled daughters as recommended by International Commission on Radiological Protection (ICRP Publication 32) and in International Atomic Energy Agency (IAEA) safety series No.9, 1982 edition. The annual limit is 0.02 J for the ^{222}Rn daughter or 5.0 WL.M ((IAEA, 1982)).The potential alpha energy of ^{222}Rn is defined as the total alpha energy emitted during the decay from ^{222}Rn to ^{210}Po, amounts to 13.7 MeV (2.3pj) per atom of ^{222}Rn (IAEA, 1987).The recommended annual limit on intake for ^{222}Rn daughters based on limiting the effective dose equivalent to 50 mSv is 20 MJ (IAEA, 1987), which corresponds to 850 WL.h or 5WL.M . It

has been estimated that the internal annual effective dose equivalent for (^{222}Rn to ^{2I4}Po) is 0.1 mSv.

II. MATERIALS AND METHODS

A safety siren pro Series 3 radon gas detector an electronic device that provides instantaneous radon gas concentration in a place over a period of time was used to determined the concentration of ^{222}Radon gas present in some residents in selected homes in Barkin- Ladi community of Plateau State Nigeria The safely siren pro radon gas detector is powered by a standard 111-120 DC battery. The device has a numeric led display which shows the level of radon gas in pico curies per litter of air (pci/L). The detector was kept in a sitting room where it cannot be disturbed, at least three feet away from doors, windows and walls of the building for about 1hr 30mins. After which the reading displayed on the numeric led of the siren pro detector was read in pci/L.

The safety siren pro series 3 gas detector has the following features; Sensor using ionization energy, Numeric led which display the level of radon gas in pci/L, Samples air continuously and two display option: short term or long term. The short term display option was used in this research.

III. DATA COLLECTION

There was no other criteria for choosing the residential homes apart from the fact that the radon concentration of the houses built on rocks is being compared with the houses not built on rocks in the areas selected for the research. The measurement was carried out in sitting rooms that was not tiled.

Data was collected in four different locations in Barkin-ladi and environs. The locations are; Gassa (Kassa), Razat, Sho and Gangare. Results for each of the measurement was obtained in pci/L, it was then converted to Bq/m^3 and micro soft excel was used to plot the graphs.

Figure 1; Map of Nigeria showing the position of Plateau state (GNS (1974) province geological survey of Nigeria).

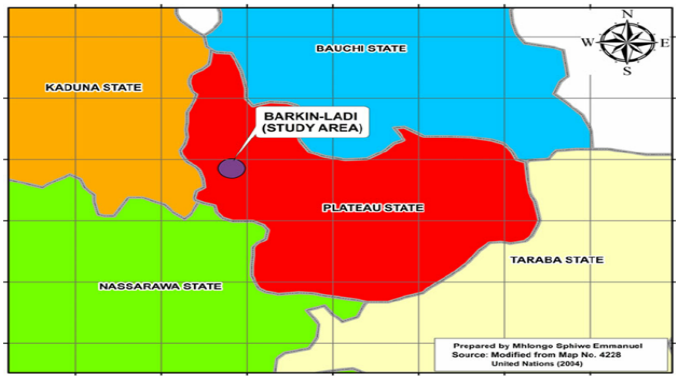

Figure 2: Map of Plateau state showing the position of Barkin-ladi L.G.A (GNS (1974) province geological survey of Nigeria).

IV. RESULTS AND ANALYSIS

The result of radon activity in the residence of the study area is shown in the table 1below.

Table 1: Radon Activity Concentration in Residents

Location	House on the rock	Pci/L	Bq/m^3	House not on the rock	Pci/L	Bq/m^3
Gassa (Kassa)	House 1	6.00	222.00	House 1	5.90	218.30
	House 2	5.90	218.30	House 2	5.90	218.30
Razat	House 1	5.90	218.30	House 1	5.90	218.30
	House 2	5.90	218.30	House 2	5.90	218.30
Sho	House 1	4.80	177.60	House 1	4.80	177.60
	House 2	4.80	177.60	House 2	4.70	173.90
Gangare	House 1	4.70	173.90	House 1	4.70	173.90
	House 2	4.80	177.60	House 2	4.70	173.90

Table 1 shows the radon activity concentration for houses in the study areas. The results were measured in pci/L and later converted to Bq/m^3. It showed that the radon gas concentration in some houses surveyed for this research exceeded the permissible value of 200Bq/m^3.

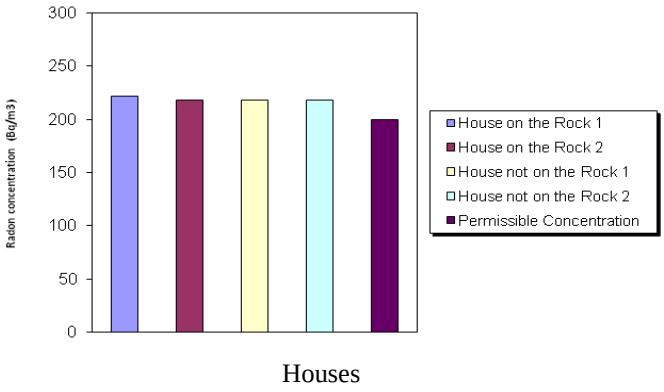

Figure 3: Radon concentration on house built on rock and house not built on rock in Gassa (Kassa).

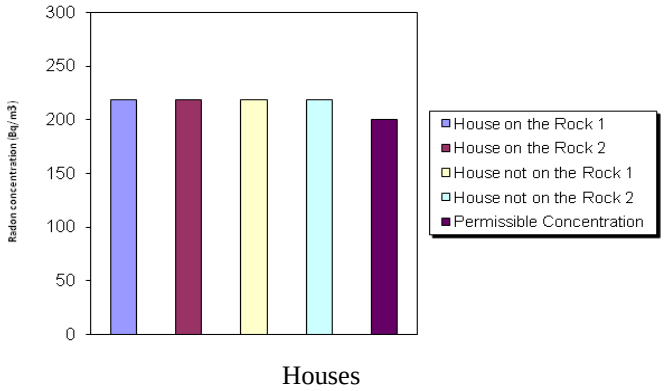

Figure 4: Radon concentration of house built on rock and house not built on rock in Razat

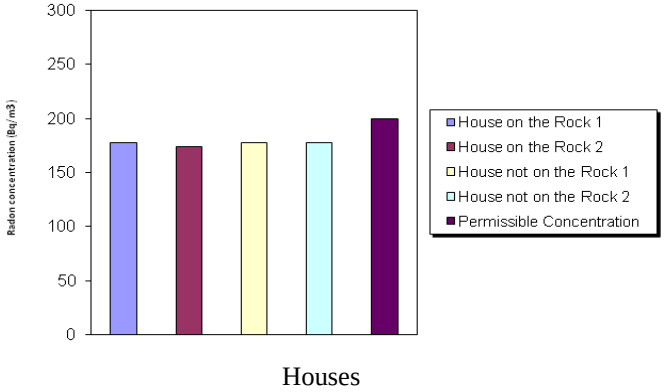

Figure 5: Radon concentration of house built on rock and house not built on rock in Sho

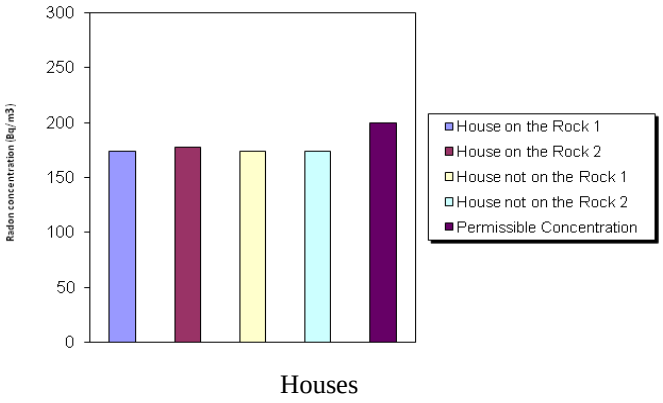

Figure 6: Radon concentration of house built on rock and house not built on rock in Gangare.

DISCUSSION

Figure3 shows a bar chart for the radon concentration in house on the rock and houses not built on rock in Gassa (Kassa). House on the rock 1 has high concentration of radon gas (222Bq/m^3) than the house that is not build on rock (218.30 Bq/m^3). while the house on rock 2 and the house that was not build on rock in the same community have the same radon gas concentration level of 218.3Bq/m^3. These values are higher than the permissible concentration value which is 200Bq/m^3. This could be as a result that the type of rock found in the area contain nuclides whose daughter is radon and the rocks might have being fractured.

Figure 4 shows that all the houses in Razat have the same level of radon which is 218.3Bq/m^3 and is higher than the permissible concentration value of 200Bq/m^3. This could be as a result that the type of rock found in the area contain nuclides whose daughter is radon, and the rocks might have being fractured.

Figure 5 shows the radon concentration of houses built on rocks and houses not built on rocks in Sho. It shows that the house on the rock 1 and house not build on the rock have the same radon gas concentration which is 177.6Bq/m^3, while the house on the rock 2 has a higher radon concentration which is 177.6Bq/m^3 than the corresponding house that was not build on the rock. All the values are lower than the permissible concentration of 200Bq/m^3. This could be as a result that the type of rock found in the area does not contain nuclides whose daughter is radon or the rocks are not fractured.

Figure 6 shows the radon concentration of house on the rock and house not on the rock in Gangare. It shows that house 1 on the rock have the same radon gas concentration level with house 1 and 2 not on the rock which is 173.9Bq/m^3 while house on the rock 2 has a higher radon gas concentration level of 177.6Bq/m^3. All the values are lower than the permissible value of 200Bq/m^3. This could be as a result that the type of rock found in the area does not contain nuclides whose daughter is radon or the rocks are not fractured.

CONCLUSION

The research shows that there is no significant difference in the radon gas concentration between the residents on rock and those are not built on rocks. However, the radon activity concentration in Gassa and Razat are found to be above the permissible limits.

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