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Assessment of Indoor and Outdoor Gamma Dose-Rate Exposure Level in Finished Building Materials Outlets in Ijebu-Ode, Ogun State, Nigeria

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Abstract

The indoor and outdoor gamma dose rate in selected commercial building materials outlets has been investigated using LK3600 radiation detector dosimeter placed at one meter above the ground level. The Dose rate for the outlet for tiles is 0.094 ± 0.015µSv/hr and estimated annual effective dose rate is 0.46mSv/yr for indoor measurements. The dose rate for the outlets for cement ranges between 0.094 - 0.105± 0.01µSv/hr. The calculated annual dose rate for cement outlets between 0.040 - 0.52mSv/yr. Also, the dose rate for different types of roofing sheets ranges between 0.050-0.095±0.014µSv for the outdoor measurement. The calculated annual effective dose rate is ranges between 0.06 - 0.13mSv/yr. The dose rate and the annual dose rate for asbestos, Iron rod and plumbing materials placed outdoor ranges between 0.06 - 0.10 ± 0.013µSv/hr and 0.05-0.13mSv/yr respectively. The dose rate for outlet with binding wires places indoor is 0.062µSv /hr and the estimated annual dose rate is 0.30msv/yr.The results showed that the building materials at these shops haveslightly increased the natural radiation dose exposure levels in the area and to the workers. The study alsoindicated that the occupants at the shops may be subjects for elevated levels of radon exposure due to confinedspace and poor ventilation. However, the values of the average and annual dose rate is lower than the world acceptable limit of 1mSv/yr. The health implication of this is that the workers and owners may not be at any significant risk for getting involved in the sales of building materials in the area.

Keywords: Indoor gamma exposure, Outdoor gamma exposure, Finished Building materials, Building material shop outlets, Annual effective dose.

1.0 Introduction

Building materials of terrestrial origin contain small amounts of NORM, mainly radionuclide from the Uranium-238 (238U) and Thorium-232 (232Th) decay chains and the radioactive isotope of Potassium-40 (40K).Also,decorative building materials like tiles derived from rock and soil include primordial radionuclide such as uranium–radium (238U–226Ra) and thorium 232Th series, and potassium radioisotope(40K) varying from one country to another and from one location to another in the same country [1]. Radiation emitted from these radionuclide in the decorative building materials like other building materials are sources of external and internal exposure indoors. External radiation exposure is caused by direct gamma radiation from the members of the 226-Ra and 232-Th series along with 40K, while internal radiation exposure is due to the inhalation of the radioactive inert gas radon (222-Rn) and Thoron (220-Rn) and their short-lived decay products, which are emitted from building materials indoors. Furthermore, man spend more than 80% of their time indoors, the internal and external radiation exposure from building materials creates prolonged exposure situations[2]. The worldwide average indoor effective dose due to gamma rays from building materials is estimated to be about 0.4 mSv per year [3].The study location will continue to have influx of population from the teeming population of neighboring state like Lagos and the probability of more structures being erected cannot be jettison and this will definitely result to more members of the public getting involved in the sales of building materials without any corresponding knowledge of the attending risk of getting into the business. This shows the importance of the study. National and International regulations and guidelines treat radioactivity in building materials as existingexposure situations rather than as planned exposure situations. Controls on the radioactivity

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concentration ofbuilding materials are based on dose criteria and on exemption levels. The dose criterion is establishedconsidering the overall national circumstances but it is thoroughly accepted that external doses exceeding 1mSv/y should be taken into account from the radiation protection point of view. Restricting the use of certainbuilding materials might have significant economical, environmental and social consequences at a local ornational level. Such consequences, together with the existing national levels of radioactivity in building materials,should be assessed and considered when establishing binding regulations. But adequate shelter is a prerequisitefor socio-economic development of any society in the today's world[4].

There had been research works on radioactivity in various building materials used inNigeria [5,6 and7], but there are few works on gamma exposure levels in outlets/shops where different types of building materials are stored and sold. The implication of this is that there havenot been well established studies to assess the exposure levels, dose and the risk to building material stores/outlets. Keepers and the exposure scenario at the building materials shops and their warehouses given the confined spacesituations which may increase radon concentrations and inhalation of the gas. Consequently, therefore, there is a general lack of awarenessand knowledge of radiological hazards and exposure levels by operators (particularly operators of smallbusinesses) and the public [4, 8 and 9]. Past research work by international body has revealed that building materials represent an important natural source of radioactivity, because they come into closest contact with humans [10]**.**To the best of the knowledge of the researcher, there had not been such research work aimed at accessing the radiological impact of occupational exposure at such spread outlets in the area. Hence the result of the research work may be used as eye-opener to the level of exposure of staff and owners of outlets and storehouse in the areawhich can be used by radiation regulatory bodies as base-line for future radiological studies in the area because of the crave for development by the general populace in the area. Finally, the result of the work will also contribute to the existing bodies of knowledge in this area of study.

The work is aimed at accessing the occupational exposure of the staff and workers of the outlets and stores involved in the sales of building materials in Ijebu-Ode, Ogun State, Nigeria to ionizing radiation from building materials. The specific purposes of the studies are:

i. Measurement of dose rate at different outlets in the area.
ii. Estimation of annual dose rate for the selected outlets
iii. Compare the result of the research work with similar done in the nation.
iv. Compare the result with internationally acceptable limit for occupational exposure to ionizing radiation.

2.0 Methodology

The dosimeter used for the work is LK3600 placed at 1meter above the ground level outdoor and indoor of the selected outlets. The dosimeter is of high sensitivity, stable and reliable.It has a high sensitivity GM counting tube.The measuring range for dose rate: 0.000usv/h—5msv/h
accumulated dose of 6-digit LCD display (000.000-999.999msv),energy response: <±30% (50KeV—1.3MeV) and relative basic error: ＜±10%(137Cs Source 662 KeV γ Radiation
1msv/h) .The in-situ dose rates at the outlets were measured with respect to where the building materials are packed. The grouping of the outlets is according to the materials in the outlets. The outlets for cement, abestors, plumbing materials, tiles, binding wires, iron rods and roofing sheets.A total of ten shops were visited.The average of the in-situ dose rates for the ten values was estimated per outlet using equation (1). Conversion calculator for radiation dose [11] was used to convert the values of dose rate in μSv/hr to nGy/hr before using equation(1) to estimate the annual dose rate for the dumpsites.

The insi-tu mean absorbed rate per hour is calculated using the equation (1)

$$X = \frac{\sum x}{n} \qquad (1)$$

Where: $\sum x$ = Summationof absorbed dose rate in micro sievert per hour
X = Mean of absorbed dose rate per hour
n= Number of data per outlet.

The annual effective dose rate to the population, H_e wascalculated by the formula:

$$H_e = DTF_O \qquad (2)$$

Where D is the calculated total dose rate , T is the occupancy time (T=f X 24 X 365.25h year $^{-1}$) f is theoccupancy factor with value of 0.2 and 0.8 for outdoor and indoor measurements respectively and F_o is theconversion factor (0.7 SvGy-1) UNSCEAR[12].

3.0 Results and Discussions

This section presents the result of the work and its pictorial representations.

Table 1: Measured Average Indoor Dose Rates (Ngy/Hr) Of Theoutlets For Building Materils.

No of outlets	**Types of Building Materials**	**Measured Average Dose Rate for Indoor (nGy/hr)**
1	Tiles	94±0.051
2	Cement	104±0.06
3	Cement	94±0.04
4	Roofing Sheet	94±0.043
5	Roofing Sheet	65±0.043(Aluminum)
6	Binding wires	62±0.030

From the table, the average dose rate from the outlet where cements are sold has the highest value (104nGy/hr).This simply due to the radioactive composition of cement. The possibility of the workers getting exposed to radon from radionuclide from the cement placed indoor continuously may have a negative heath effect on the workers particularly in the outlets where the ventilation is not too good as seen in some of the outlets.Howver,the value got is smaller than the world acceptable limit for occupational exposure(1 mSv/yr) for the public and lower than world average effective dose rate of 0.07mSv/yr[13,14 and 15]

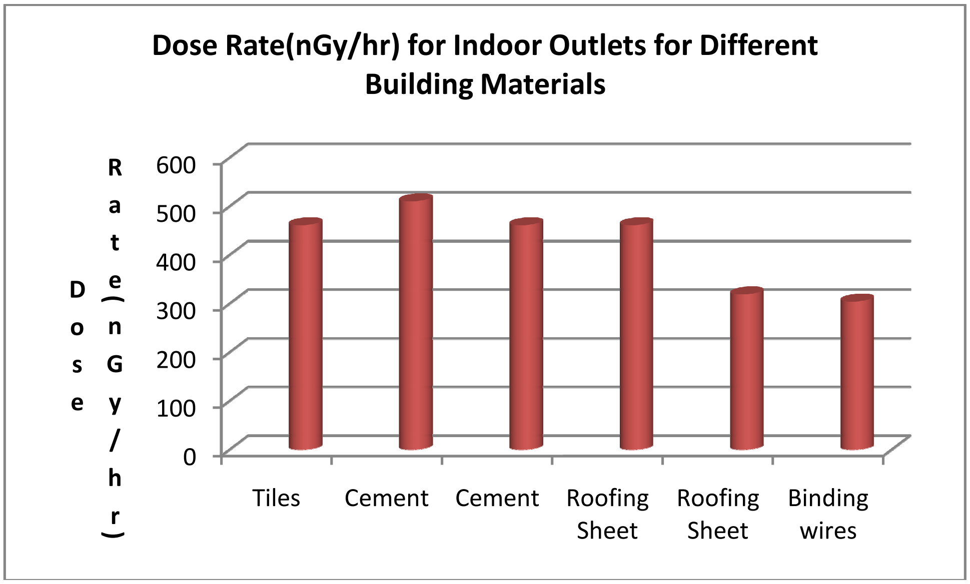

FIG 1: Pictorial Presentation for Indoor Door Rate for Outlets

Table 2: Measured Outdoor Dose Rates (Ngy/Hr) of the Outlets

No of Outlets	**Types of Building Materials**	**Measured Average Dose Rate for Indoor (nGy/hr)**
1	Plumbing Materials	88±0.051
2	Asbestos	67±0.029
3	Iron Rods	94±0.054
4	Roofing Sheet	98±0.057
5	Roofing Sheet	65±0.043

From the table, the highest value roofing sheet, the value is also lower than the world acceptable limit of 1mSv/yr for the general public.

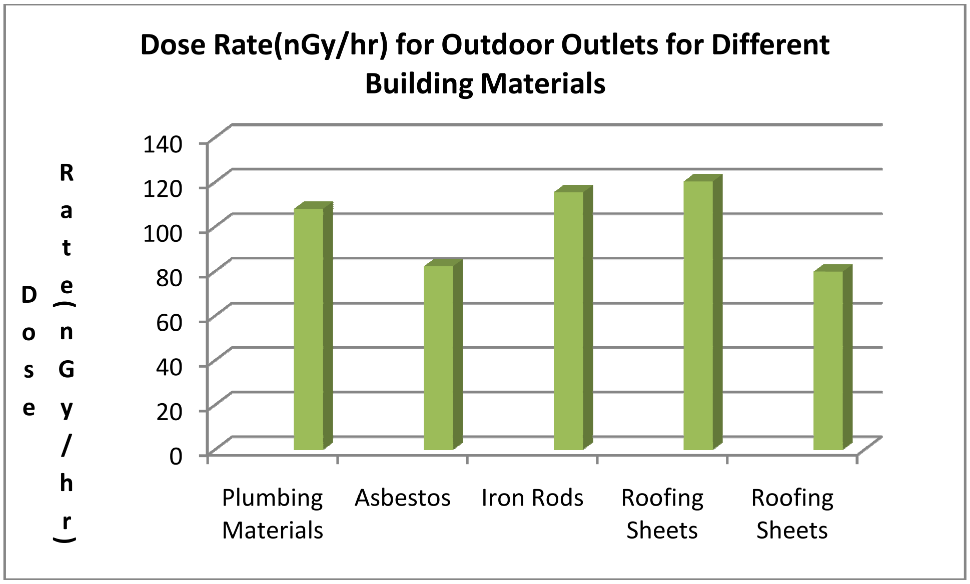

FIG 2: Pictorial Presentation for Outdoor Door Rate for Outlets

Table 3: Annual Indoor Dose Rates (Msv/Yr) of the Outlets

No of Outlets	Types of Building Materials	Measured Annual Dose Rate for Indoor (µSv/yr)
1	Tiles	461.4
2	Cement	510.5
3	Cement	461.4
4	Roofing sheet	461.4
5	Roofing sheet	319.1
6	Binding wires	304.4

From the Table, again the highest value of annual dose rate is from outlets that sell cement stored in the outlets. The risk of radon inhalation for poor ventilation can be of health risk for the workers that spend more time indoor where the cements are packed.

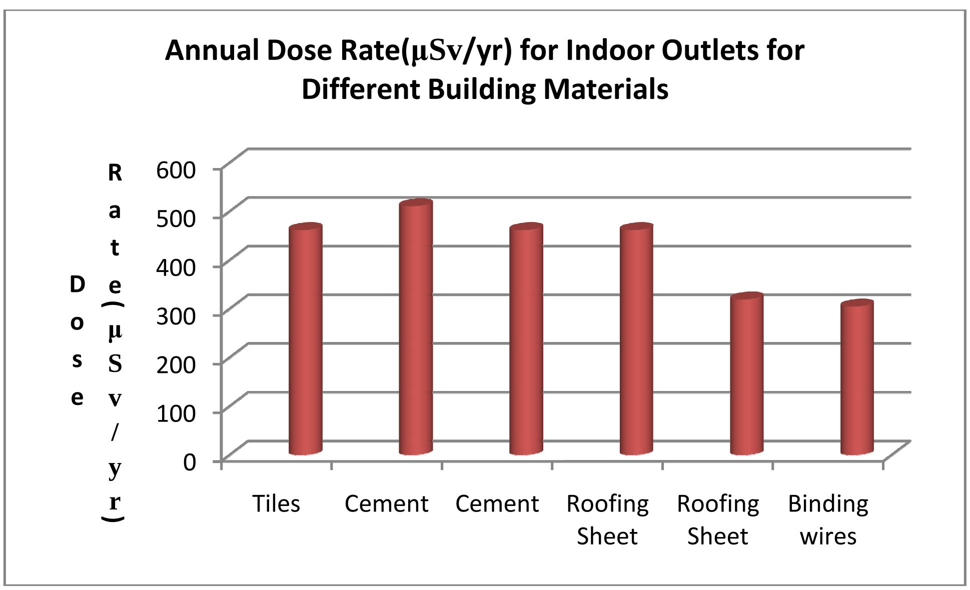

FIG 3: Annual Dose Rate(µSv/yr) for Indoor Outlets for Different Building Materials

Table 4:AnnualOutdoor Dose Rates (μsv/yr) of The Outlets.

No of outlets	Types of Building Materials	Measured Average Dose Rate for Outdoor (μSv/yr)
1	Plumbing Materials	108.0
2	Asbestos	82.2
3	Iron Rods	115.4
4	Roofing Sheet	120.3
5	Roofing Sheet	79.8

The highest value is from plumbing materials packed out door and the value is not significant to be of negative health effect to the the workers in the outlet.

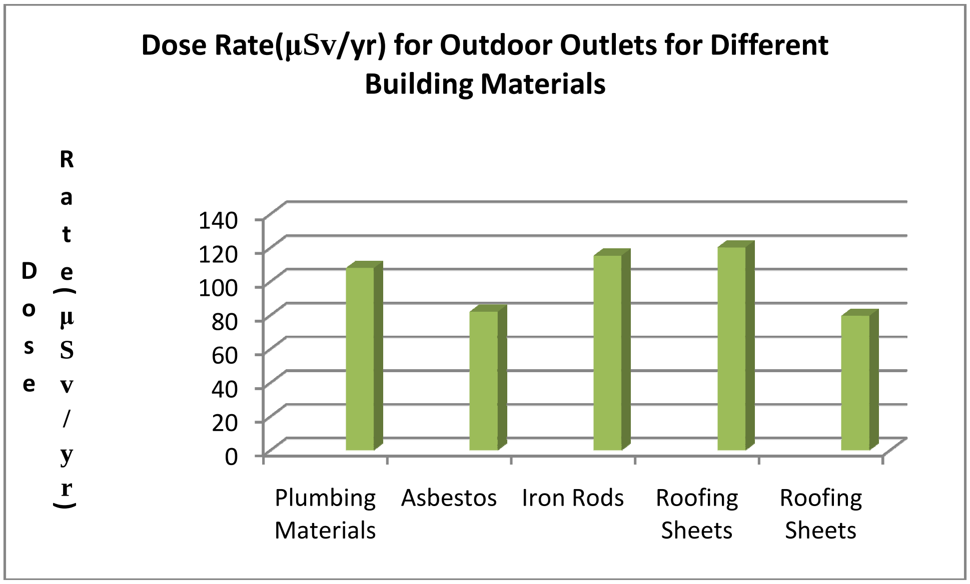

FIG 4: Annual Dose Rate(μSv/yr) for Indoor Outlets for Different Building Materials

4.0 Conclusion

The gamma dose rate for both outdoor and indoor for outlets involved in selling of building materials have been investigated and the values gotten is lower than the world acceptable limit of 1mSv/y. The radiological implication of the result is that there can be no health effect on the owners and workers of the outlets. However, workers in outlets with poor ventilation can be endangered by the continuous inhalation of radon gas from some building materials that are radioactive cement.The values of the gamma dose rate indoor of the outlets are higher than the ones out door. This also suggest the possibility of radon inhalation of the workers.

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