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Method Article

Assessment of natural radioactivity in various commercial tiles used for building purposes in Nigeria

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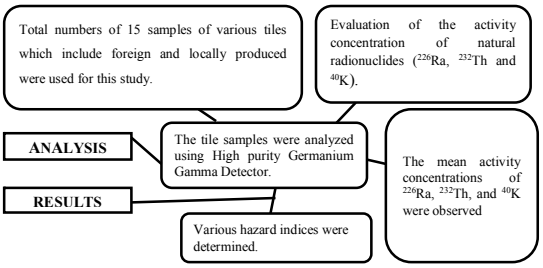
GRAPHICAL ABSTRACT



ABSTRACT

In this study, we evaluated the activity concentration of natural radionuclides (^{226}Ra, ^{232}Th and ^{40}K) for fifteen (15) different brands of tile samples used for building purposes in Nigeria. The tile samples were analyzed using High purity Germanium gamma detector. The mean activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K were observed to be 61.1 ± 5.5 Bq/kg, 70.2 ± 6.08 Bq/kg and 514.7 ± 59.8 Bq/kg respectively. Various hazard indices such as absorbed dose rate, external and internal hazard index, annual effective dose rate, Gamma activity Index (Iγ) and Alpha Index (Iα) were calculated. The obtained results showed that the mean radium equivalent activity (Raeq), the absorbed dose rate (D), external and internal hazard index, the annual effective dose (AEDR) equivalent, Gamma activity Index (Iγ) and Alpha Index (Iα) were: 204.42 Bq/kg, 177.61 nGyh^{-1}, 0.55, 0.77, 0.96 mSvyr^{-1}, 0.74 and 0.32 respectively. The average value of radium equivalent obtained in this study is less than that of the

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recommended value of 370 Bq/kg but the average values of the other radiological hazards for some samples are found to be slightly above international recommended values except H_{ex}, H_{in} and AEDE which are within the international reference value of unity. The measured concentrations of these radioactive materials were correlated with other previous result obtained from similar tile materials used in other countries and found to be in good agreement with the international standard, however, the tiles are recommended for decoration purposes in Nigeria.

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Method details

Humans society have always been exposed on daily basis to natural radionuclides such as ^{232}Th, ^{226}Ra and ^{40}K [1]. These radionuclides in the series are headed by ^{226}Ra (^{238}U) and are relatively less important from a dosimetric point of view [2]. The origin of these materials is the Earth's crust, but they find their way into building materials, air, water, food and the human body itself. The world wide average indoor effective dose due to gamma rays from building materials is estimated to be about 0.4 mSv per year [3,4]. Globally, building materials that contain radioactive nuclides have been used for many decades. As individuals spend more than 80% of their time indoors, the internal and external radiation exposure from building materials creates prolonged exposure situations [5]. The external radiation exposure is caused by the gamma emitting radionuclides, which in the uranium series mainly belongs to the decay chain segment starting with ^{226}Ra. The internal (inhalation) radiation exposure is due to ^{222}Rn, and marginally to ^{220}Rn, and their short lived decay products, exhaled from building materials into the room air [4]. Papastefanou et al. [6] carried out a study in Greece on building materials, which showed that out of the investigated building materials such as tiles which are by product of granite, phosphogypsum etc. are highly radioactive materials for which the absorbed dose rate in indoor air becomes up to five times higher than the dose criterion. Such radioactive materials contribute significantly to radiation exposure because they comprise gamma and beta emitters [7,1]. Building materials, derived from rock, sand, soil and byproduct of industry, often contain varying amounts of natural radionuclides [8–10]. The knowledge of the natural radioactivity level of building materials is important for determination of population exposure to radiation. Furthermore, knowledge of this radioactivity is useful in setting the standards and national guidelines for the use and management of these materials and in assessing the associated radiation hazard to human health [11]. The natural radioactivity level of building materials can vary considerably according to the geological locations and geochemical characteristics of those materials. Due to the increasing social concern, the natural radioactivity level of building materials has been reported in many countries [12–22]. The objectives of the study are to evaluate the activity concentration of natural radioactivity content in the commonly used building materials such as tiles of various types and sizes in Nigeria and to estimate the radiation hazards associated to individuals by using radium equivalent activity, external and internal hazard indexes, indoor air absorbed dose rate and annual effective dose rate. The results are compared with the internationally reference values to ascertain the safer tiles useful for building purpose in Nigeria.