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Range of Alpha Particles in Human Tissue

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Abstract: In this study, we have concentrated measuring range of alpha particle in air, tissue and bone using energy for element that emit alpha particle from uranium series. And investigate the correlation between the range of alpha particles and cancer in lung and bone and using equations to describe the effect of alpha particle in human tissue. United nation data suggested that 3*10'Bq could induced lung cancer. The National Radiological Protection suggested that the average exposure to ionizing radiation in United Kingdom is now 2.5 mSv/year at 1988, compared with just under 2.2 mSv/year at 1984 in United State. In this study, we have concentrated measuring range of alpha particle in air, tissue and bone using energy for element that emit alpha particle from uranium series.

Key words: Range, alpha particle, energy, uranium series, bone, tissue

INTRODUCTION

We are interested in alpha particle for two reason, one is good and the other is ugly. It can be good if we used it for therapy. Many medical centres used it for brachytherapy this means using source emits alpha particle for internal radiation to damage the tumour cells, since, it has a range of few millimetres it will only damage the tumour tissue not the normal tissue in the surrounding. The ugly side of alpha particles if it come from source outside the body if it external, the hazard is negligible, due to its short range, since, they cannot penetrate the outer layer of the skin but they can do significant damage if they come from material which has been inhaled or swallowed where the induction of cancer might occur. The main external exposure to alpha particle is the exposure to uranium-radium daughter, since, both of them only natured alpha source emitter (Davis, 1967).

Radioactivity refers to the particles which are emitted from nuclei as a result of nuclear instability. Because the nucleus experiences the intense conflict between the two strongest forces in nature, it should not be surprising that there are many nuclear isotopes which are unstable and emit some kind of radiation. The most common types of radiation are called alpha, beta and gamma radiation but there are several other varieties of radioactive decay.

Alpha radioactivity composed of two protons and two neutrons, the alpha particle is a nucleus of the element helium. Because of its very large mass (more than 7000 times the mass of the beta particle) and its charge, it has a very short range (Spellman, 2006). It is notsuitable for radiation therapy, since, its range is less than a tenth of a millimetre inside the body. Its main radiation hazard comes when it is ingested into the body it has great destructive power within its short range. In contact with fast-growing membranes and living cells, it is positioned for maximum damage. Alpha particle emission is modelled as a barrier penetration process. The alpha particle is the nucleus of the helium atom and is the nucleus of highest stability.

MATERIALS AND METHODS

Penetration of matter: Though, the most massive and most energetic of radioactive emissions, the alpha particle is the shortest in range because of its strong interaction with matter. The electromagnetic gamma ray is extremely penetrating even penetrating considerable thickness of concrete. The electron of beta radioactivity strongly interacts with matter and has a short range (Fig. 1) (Lindsey and Ator, 1996).

Alpha particle and radon gas: Because radon is a gas, it can move from the soil into the house where the lung tissue can be exposed to radiation from short lived decay product from uranium series (Fig. 2).

Radon has 3.8 days half-life it has enough time to move from radium source in building and consequently deposited in the lung tissue. The decay products, Bismuth, polonium and lead have very short half-life

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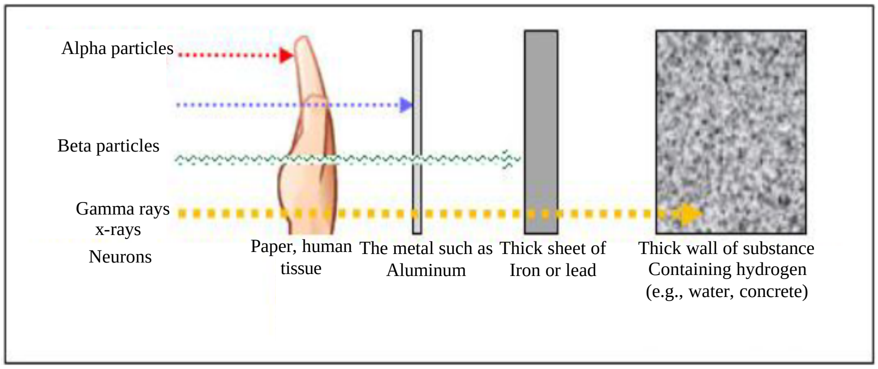

Fig. 1: Penetration of matter

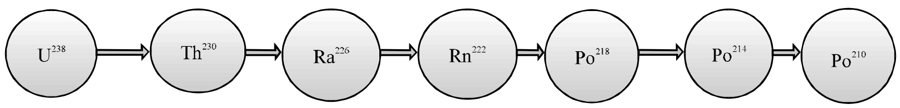

Fig. 2: Radiation from short lived decay product from uranium series

producing additional alpha particle that can also damage to the lung tissue. The energy released by alpha particle can cause damage to DNA molecules. This is why exposure to radon and radon decays increase that risk of cancer. It is recommended by the USA government, thus, that all homes below the third floor be tested for airborne radon that may enter the home through the basement, especially in the areas whose contains high concentration of granite (Lindsey and Ator, 1996).

Radon and its daughter products have been linked to lung cancer and possible leukaemia. When radon is inhaled, it can become embedded into sensitive cilia lining can be damaged, additionally as radon decays, it can become polonium which has been strongly linked to lung cancer. New research has suggested that AC power cables, causes radon to be concentrated about the carrying cable and attached to the skin (Henshaw *et al*., 1996; Cameron and Skofronick, 1978; Gibson and Ahmed, 1973; Oatway *et al*., 2006).

RESULTS AND DISCUSSION

Alpha emitting nuclides: Alpha particle consists of 2 neutrons and 2 protons and it is identical to the nucleus of helium atom. There are many isotopes which occur naturally that emits alpha particleand this means that there always-alpha activity in food and in people. In addition there is alpha emitter isotopes that are produced artificially in nuclear reactor. Radiological, the most important isotopes that are those of plutonium which are produced by electron captured and beta decay from uranium (Gibson and Ahmed, 1973). Plutonium is chemically similar to calcium and if taken into the body it is deposited in bone where the radiation can damage the blood forming organs (bone marrow). Po 210 is important and measured in children teeth. Po 210 is present attached to aerosols emitted from car exhausts (Raaschou-Nielsen, 2008).

In this study, we have concentrated measuring range of alpha particle in air, tissue and bone using energy for element that emit alpha particle from uranium series. Because an alpha particle is charged, it ionizes air molecules as it travels through air. The alpha particle loses energy as it ionizes air molecules. The greater the energy of the alpha particle the farther in penetrate air at standard temperature and pressure (Fig. 3a-c).

Data and data analysis

Particle range relations: The distance it travels to its stopping point is called the range. The range can be determined by measuring the distance that different energy alpha particles travel in air (Fig. 4 and 5) (Alpen, 1997). We use the following equations:

$$R = 0.325\times E^{\frac{3}{2}} \quad (1)$$

$$R = \frac{3.2\times10^{-4}\sqrt{A_s}}{\text{Density}}R_{air} \quad (2)$$

- R = Range of alpha particle in cm
- A_s = Averages mass number of substance

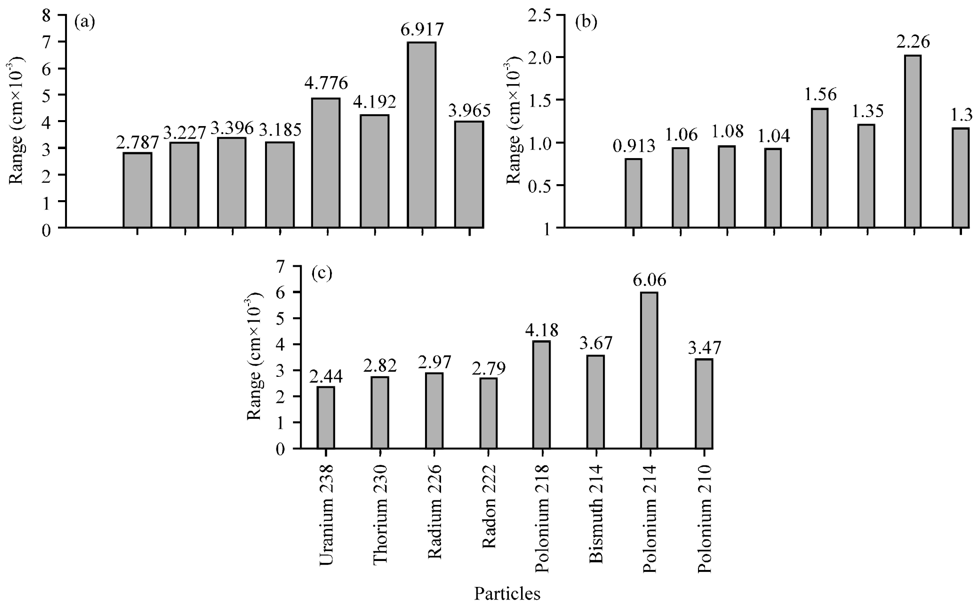

Fig. 3: a) The range of alpha particle in air; b) The range of alpha particle in bone and c) The range of alpha particle in tissue

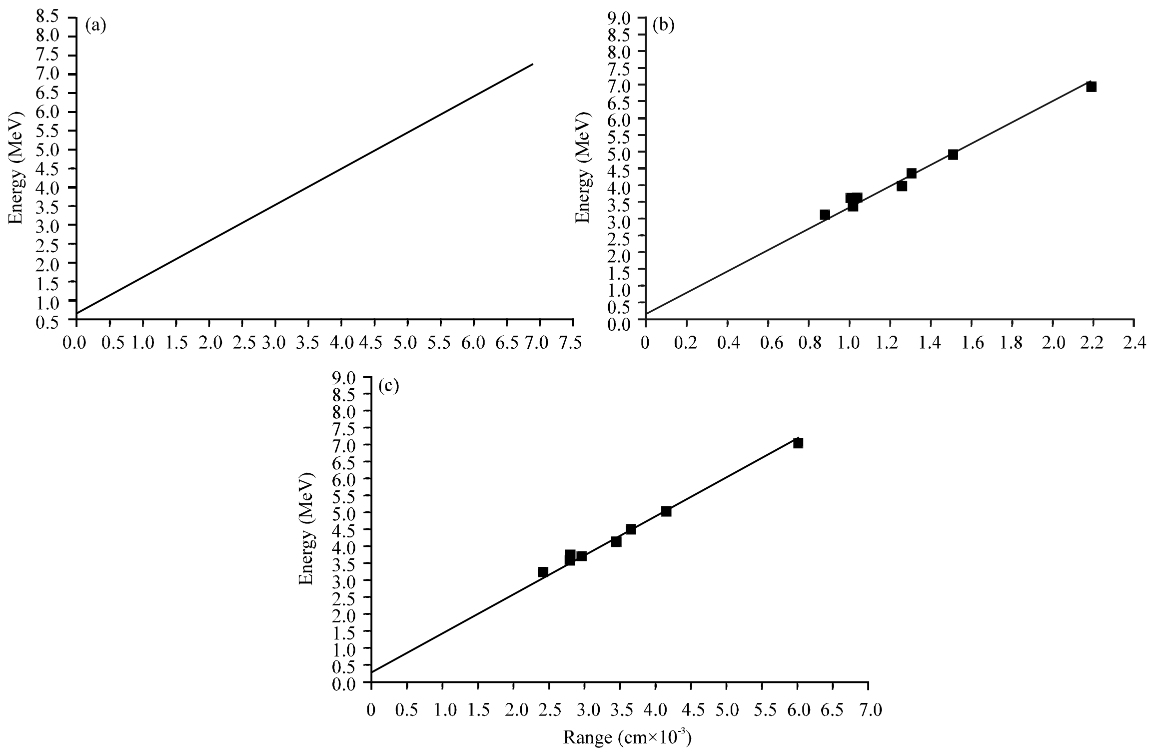

Fig. 4: a) The energy of alpha particle in air; b) The energy of alpha particle in bone and c) The energy of alpha particle in tissue

- Density (air) $=1.205\times10^{-3}$ g/cm^3
- Density (tissue) $=1.00$ g/cm^3
- Density (bone) $=1.85$ g/cm^3
- A_s (air) = 7.78
- A_s (tissue) = 7.51
- A_s (bone) = 12.31

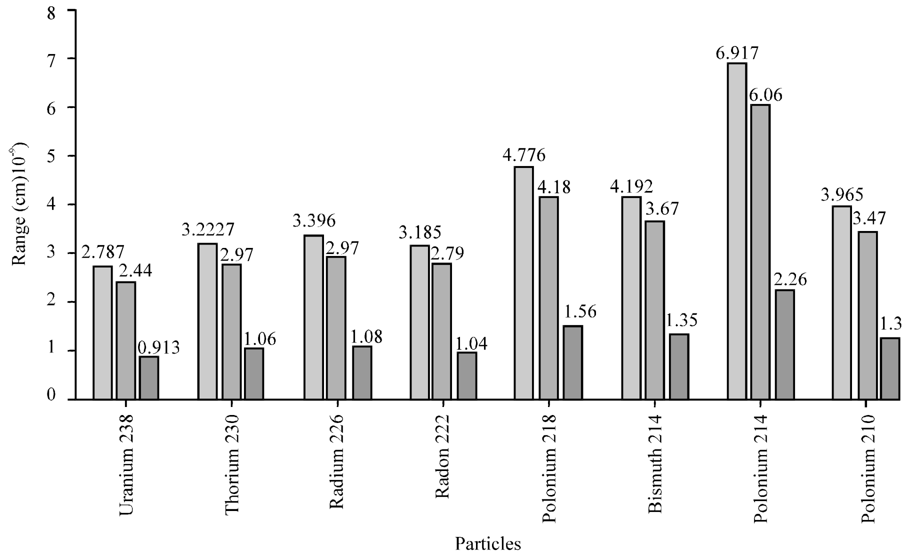

Fig. 5: Alpha particles in air, tissue and bone

CONCLUSION

We measured the range of alpha particles in air, tissue and in bone. We noticed that the range of alpha particles for example (radon gas) in air is about 3.18 cm, while in the tissue is about 2.79 10 cm and in bone is about 1.04*10 cm from these data we conclude that alpha particles can penetrate the tissue more than in bone, this mean that the probability to cause lung cancer is more than to cause bone cancer.

We show from histograms that the radon has the shortest range of all the uranium source-decays but it has the largest hazard because all the other decays is from solid state radionuclides (it cannot penetrate the outer layer of the skin, since, the radon is a gas, this mean, it can be inhaled and make the damage to the tissues.

From the graphs (Energy versus range) for air, tissue, and bone, we can show that when the energy increase the range should also be increase that we also measure the LET and we noticed that its about 90.9 keV/μm in air and 108.3 keV/μm in tissue and 233.3 keV/μm in bone this mean it has the maximum value for bone due to its little penetrations. This study shows the remarkable effect of the existence of radon gas in the surrounding, since, it's around us, so, we cannot avoid it while in the other alpha emitter the existence of source is clear enough to be avoided.

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