GROSS ALPHA AND BETA RADIOACTIVITY LEVELS MEASUREMENT IN MINING PONDS IN JOS METROPOLIS- PLATEAU STATE, NIGERIA

BY

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INTRODUCTION

Nature has provided immense natural resources to humanity. Water is one such natural resource which is essential for human life and for health and the environment. The first health requirement for any developing country is the abundance of clean water supply. Water the most indispensable and precious natural resources are expected to be free from pollution. It has two parameters which are closely linked, quantity and quality. In nature, all water contains some impurities. Water quality is one of the highest priority environmental issues. The water resources of a nation determines the food production, industrial growth, public health and hence its economy (Marbanaing, 2011).

Natural radioactivity is always present in the environment. Water especially ground water, is not free of radioactive isotopes from naturally decaying series of ^{238}U, ^{232}Th and ^{40}K. It is natural to find radionuclides in drinking water. They get into water as it comes in contact with radioactive materials in the solids. The activity concentrations of natural radionuclides in ground water are connected to the activity concentrations of ^{238}U, ^{232}Th and their decay products in the ground water and bedrock (Vesterbacka, 2007). This is due to ground water reacting with the ground water and bedrock and releasing quantities of dissolved components that depend on the mineralogical and geochemical composition of the soil and rock, redox conditions and the residence time of ground water in the soil and bedrock (Fasae, 2013).

Clean and plentiful water provides the foundation for prosperous communities. We rely on clean water to survive, yet right now we are heading towards a water crisis. Dirty water is the world's biggest health risk and continues to threaten both quality of life and public health in the developing countries like Nigeria. When water from rain and melting snow runs off roofs and roads into our rivers, it picks up

toxic chemicals, dirt, trash and disease-carrying organisms along the way which may increase its radioactive content. Many of our water resources also lack basic protections thereby making them vulnerable to pollution from factory farms, industrial plants to mention but a few. The aforementioned can lead to drinking contamination of water bodies which is most likely to come from naturally occurring radionuclides which are potential contributors of alpha, beta and gamma radioactivity in underground water supply system (Onoja, 2005). Radioactivity in drinking water is principally derived from leaching of radionuclides from rocks and soils. Dissolving from underground minerals and move along with the water as well as deposition of radionuclides from the atmosphere. On the other hand (Forte *et al*, 2006) established that, the geographical/geological formation of an area determines to some extent the radionuclides present in water. Wells and boreholes constricted in bedrocks within such areas could show some levels of natural radioactivity. Enhanced levels of Uranium, Thorium and their daughters' products might be present in waters that are rich in natural radioactivity. Uranium isotopes (^{238}U, ^{234}U and ^{235}U) have a non-negligible radiotoxicity (WHO, 1978; Malcome-Lawes, 1979). Furthermore, several radionuclides in the radioactive decay chain starting from ^{238}U, ^{235}U are highly radiotoxic.

According to Ahmed, 2004 the most radiotoxic and the most important among such radionuclides is radium, which is a known carcinogen and exists in several isotopic forms. The predominant radium isotopes in groundwater are ^{238}Ra, an alpha emitter with a half-life of 1600 years and beta emitters, with a half-life of 5.8 years (Lyenger, 1990; Marovic *et al*, 1996; Sidhu and Breithart, 1998). Considering the high radiotoxicity of alpha and beta emitters their presence in water and their associated health risks it is glaring that they require proper attention. It is known that even small amounts of radioactive substance may produce a damaging biological effect and that ingested and inhaled radiation can be a serious health risk (Rowland, 1993). When radium is taken into the body, its metabolic behavior is similar to that of calcium and an appreciable fraction is deposited in the bone while the remaining fraction being distributed almost uniformly in soft tissues (Wrenn, *et al,* 1985). An important aspect of radium protection is the prevention of its entry into the human body, the critical pathway being ingestion through the food chain or drinking water (Kahlos and Asikainen, 1980).

Materials and Method

Twenty (20) water samples were collected from the mining ponds in Jos metropolis of Plateau State- Nigeria. The samples were collected in 2 litres plastic containers with about 1% air space left for thermal expansion. To minimize contamination, the containers were first rinsed three times with samples water before use. The water samples were immediately acidified with 20ml ± 1ml of nitric acid per litre of sample collected to minimize absorption of radioactivity into the walls of the containers (ISO, 9697 & 9698; 1992a). The samples were then tightly covered and kept in the laboratory. For the purposes of analysis the samples were slowly evaporated without boiling down to a volume of 50ml at a furnace temperature of 60^0C. The residue was then transferred to a stainless steel planchet, dried and allowed to equilibrate with ambient temperature and weighed. The counting time was 3000s.

Results and Discussion

The gross alpha activity in the mining ponds water ranged from (0.006 ± 0.002)Bq/L for TMP09 to TMP02 where the activity concentration was (0.144 ± 0.003)Bq/L with a mean value of (0.0382 ± 0.0007)Bq/L. The gross beta activity concentration ranged from (0.355 ± 0.330)Bq/L from TMP11 to (11.319 ± 0.519)Bq/L for TMP09 with mean value (1.721 ± 0.356)Bq/L.

The alpha activity concentrations in all the ponds water samples examined were within the practical screening level of 0.1Bq/L except for samples collected from TMP06 and TMP09 which are slightly above this value. The gross beta activity values for eighteen (18) out of the twenty mining ponds analyzed were above the recommended WHO acceptable limit of 1.0 Bq/L. In other words, all of the twenty (20) mining ponds analyzed only TMP01 and TMP03 were within the screening level. These high levels of gross beta activity may suggest the presence of pollutants of anthropogenic origin as screening for beta activities in the environment is screening for artificial or anthropogenic radionuclides (Ezekiel, *et al*, 2013). Such pollutants in the tin mining areas could be the mines tailings (which are made up of mainly zircon and monazite) which are usually rich in Uranium and Thorium.

The committed effective dose gives a good approximation of the effective dose rate of our bodies and is a function of the quality of water consumed for year among other factors. It is assumed that on the average adults consume about two litres of water per day which is equivalent to 73L/yr,

while children consume about 200L/yr (Fernandez *et al*, 1992, WHO 2004, Fasae, 2013). The committed quantities because of small effective half-lives are practically realized within one year after intake (Fasae, 2013). In this work the committed effective dose (CED) over one year was calculated using the formula given by Fasae, 2013 as:

$$CED = I\ A\ C \times 365 \qquad (1)$$

Where I = the daily water consumption, A = the alpha activity concentration in Bq/L and C = is the dose conversion factor for ingestion and for an adult the value is 2.8 x 10^{-4}mSv/Bq while for children it is 1.5 x 10^{-3} mSv/Bq. For a given gross alpha and beta the values for the estimated effective dose for gross alpha ranged from (0.002 – 0.030)mSv/yr with a mean value of 0.009mSv/yr for an adult while the values for children ranged from (0.18 – 3.55) mSv/yr with a mean value of 0.624mSv/yr. When these values are compared with the WHO acceptable limit of 0.1mSv/yr for the general public, the mining ponds may be considered to be highly radioactive to children than the adults.

CONCLUSION

Gross alpha and beta activity concentrations in mining ponds and water of Jos metropolis, Plateau State were measured. The results obtained for gross beta were generally higher than the gross alpha activity concentrations. The estimated committed effective dose to children and adults were also calculated in which some values were above the WHO standard of 0.1mSv/yr for the general public. Hence long term accumulated effects should be guided particularly in the ponds where elevated activity concentrations were obtained during the survey.