Determination of Gross Alpha and Beta Concentration and Annual Committed Dose In Drinking Water Sources of Ampang West and Kerang in Mangu L.G.A., Plateau State, Nigeria

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Abstract:-**Naturally occurring radionuclides of terrestrial origin, also termed primordial radionuclides, are present in various degrees in all environmental media, including the human body. Dose from ingestion are mostly from the gross alpha and gross beta present in food and drinking water. The samples of water used for this study were collected from eight sources of drinking water from Ampang west district and Kerang district both in ManguLGAs of Plateau State, Nigeria. The samples were analysed using Protean Instrument Corporation (PIC) MPC2000DP, and the results of the analysis shows that the gross alpha and beta activity in the water ranges from 0.0104± 0.002 Bq/L to 0.1381 ± 0.013 Bq/L and 0.0103 ± 0.014Bq/L to 0.1612 ± 0.029 Bq/L respectively. The values are below the 0.5Bq/L for gross alpha and 1.0Bq/L for gross beta acceptable limit by WHO. The entire calculated annual committed effective dose for both alpha and beta activity where below the limit of 0.1mSv/yr. The results obtained from the analysis, is evident that the water has not been polluted by radioactive materials and hence would not be harmful for human consumption.**

Keywords: **Gross alpha, gross beta, activity concentration, water, dose**

I. INTRODUCTION

Water is fundamental to life here on earth, and is one of the most valuable resources. The supply of clean and abundant water sources is a major challenge facing modern civilization (Gyuk, *et al.*, 2017). Nigeria is party to the united nation declaration of the right to water, which entitles every one living in Nigeria to sufficient, affordable, safe and acceptable water for personal and domestic uses. Supply of safe drinking water is crucial to human life and safe drinking water would not constitute a significant risk to humans (WHO, 2011). Water being a universal solvent has many substances dissolved in it. These include those that are beneficial and those harmful to man. Its quality therefore, depends on factors such as geological morphology, vegetation and land use (Oluyemi*et al.*, 2010 and Mishsra*et al.*, 2013).

Human activities and some natural phenomenon may pollute this water and thus affecting its quality. Some of these human activities include sewage disposal, leaching of fertilizers from the soil, industrial wastes disposals etc. Some of these waste disposals may often contain some radioactive materials which contribute significantly to the background activity of the water bodies (Gondar, 2011). Other forms of water pollution are as a result of certain rock types containing radioactive elements referred to as Naturally Occurring Radioactive Materials (NORM). These materials disintegrate and thereby emitting alpha particles, beta particles or gamma radiation. Drinking water sourced from deep wells and boreholes are usually expected to have high concentration of radionuclides. This is because they pass through fractures in bedrocks or within the soil which contains minerals deposits that might have radioactive constituents and thus leaking into the water ways.

Radioactivity in drinking water is one of the major ways in which radionuclides from the environment gets into the human body, which might consequently lead to radiation-induced disorder (USEPA, 2010). There is evidence from both human and animal studies that radiation exposure at low to moderate doses may increase the long term incidence of cancer and that the rate of genetic malformations may be increase by radiation exposure (Otton, 1994). It is therefore important to determine the amount of radionuclides in drinking water for every area where people live in, so as to guard against its health hazards (WHO, 2006).

Radioactivity in drinking water is an important mode of transfer of radionuclides from environment to man. The most important natural radionuclides in drinking water are tritium, potassium-40, radium, radon and gamma emitters. Thus, measuring the radioactivity in drinking water is of great interest in environmental studies (Ajayi and Owolabi, 2008). A gross alpha test is the first step to determining the level of radioactivity in drinking water. This test serves as a preliminary screening device and determines whether additional analysis is advisable (Ajayi and Owolabi, 2008). Gross alpha is more of concern than gross beta for natural radioactivity in water as it refers to the radioactivity of Th, U, Ra as well as Rn and daughters (USEPA, 1997). If the gross alpha and gross beta are less than 0.5 and 1.0Bq/L respectively, it can be assumed that the Total Indicative Dose

(TID) is less than the parametric indicator value 0.1mSv/yr. If the gross alpha activity exceeds0.5Bq/L or gross beta activity exceeds 1.0Bq/L, analysis for specific radionuclides is required (WHO, 1993). Most of the internal radiation doses received by human beings are due to the eating and drinking of food and water contaminated with different radionuclides. Adequate supply of safe and portable water assist in preventing the spread of gastrointestinal diseases, support domestic and personal hygiene and improves standard of living. However, most of the world's population does not have access to safe drinking water.

This researched therefore is aimed assessing the gross alpha and gross beta concentration and committed effective dose in selected samples of drinking water in Ampang west and Kerangof Mangu Local Government Area of Plateau State.

II. MATERIALS AND METHODS

The equipments used for the research work are: Protean Instrument Corporation (PIC) MPC2000DP, Lenoir city, TN37771 United State of America, Beakers, petri-dishes, measuring cylinders, Hot Plate and Electronic weighing Balance.

Sampling Area: The sampling was done inAmpang west and Kerang both in Mangu Local Government area, Nigeria.

Sample Collection: The water samples were collected from four different sources in the two districts thus; Ampang west central borehole, Chwakshii pond, Perka well water and Larpiaborehole all in Ampang west District and Kerang central borehole, Kurgwam well, Taminus borehole and Dungbin stream water all in Kerang District. The water samples were collected in plastic containers which were washed and rinsed with distilled water. During sampling, the plastic containers were rinsed with sample water three times. After collection of each sample, few drops of trioxonitrate (V) acid were added, to prevent the metals from being adsorbed by the wall of the container. The samples were then labeled and transported to laboratory, stored at room temperature prior to analysis.

Sample analysis: The liquid samples were first evaporated on a hot plate. About 1 litre of the water sample was put in a beaker and evaporated. When the water evaporated to about 50ml in the beaker, it was transferred into a Petri-dish and then put under an infrared light to completely dry. The total volume evaporated was taken and recorded with the aid of an analytical balance. The weight of empty Petri-dish was recorded before the surface drying. Then the weight of the petri-dish + residue after the drying was recorded. The total residue was obtained by subtracting weigh of empty petri dish from weigh of Petri dish after drying. Few drops of acetone were introduced to absorb the moisture content of the residue. Thereafter Vinyl acetate was added to serve as adhesives between the planchet and the sample. MPC 2000 dual phosphate gas detector was used for counting of the gross alpha and gross beta in all the samples.

The Annual committed Effective Dose

The committed effective dose is based on the risk of radiation induced effects and the use of the International Commission on Radiological Protection (ICRP) metabolic model that provides relevant conversion factors to calculate effective doses from the total activity concentration of radionuclides measured. To quantify the dose intake to human for the consumption of water from these sources and to quantify the health risk/ hazards associated with the consumption of such waters, the effective equivalent dose to man is estimated. This estimation gives a good approximation of the effective dose rate of our bodies and is a function of the quantity of water consumed per year among other factors. On the average, adults are assumed to consume two litres of water per day which corresponds to 730 L/y, while children are assumed to consume about 200L/y (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 (Turner, 1995 in Fasae, 2013). In this work, the committed effective dose (CED) over one year was calculated using formula given in (Fasae, 2013) as;

$$CED = IAC \times 365 \qquad (1)$$

Where I is the daily water consumption in one day, A is the alpha activity in Bq/L and C is the dose conversion factor for ingestion. For an adult, $C = 2.8 \times 10^{-4} mSvBq^{-1}$,while for children's, $C = 1.5 \times 10^{-3} mSvBq^{-1}$for a given gross alpha and beta.

III. RESULTS AND DISCUSSION

Table 1: Gross Alpha and Beta Radioactivity Concentration (Bq/L) of some selected drinking water and the Committed Effective Dose in some parts of Ampang west and Kerang district of ManguLGA of Plateau State

S/No.	Sapling area	Activity concentration Bq/L		α-Annual Committed Effective Dose mSv/yr		Beta-Annual Committed Effective Dose mSv/yr	
		Alpha	Beta	Children	Adult	Children	Adult
1	Ampang central borehole	0.0246±0.005	0.0515±0.011	0.007	0.005	0.015	0.011
2	Chwakshii pond	0.0104±0.002	0.0040 ± 0.01	0.003	0.02	0.012	0.010
3	Perka well	0.0606±0.006	0.0103±0.014	0.018	0.012	0.003	0.002

4	Larpia borehole	0.105±0.004	0.0679±0.080	0.030	0.021	0.020	0.014
5	Kerang central borehole	0.1381±0.013	0.1612±0.030	0.041	0.028	0.050	0.033
6	Kurgwam well	0.0423±0.004	0.0619±0.009	0.013	0.009	0.019	0.013
7	Taminus borehole	0.0295±0.004	0.0556±0.009	0.009	0.006	0.017	0.011
8	Dungbin stream	0.0204±0.002	0.0316±0.004	0.006	0.004	0.009	0.006

Table 1, gives the gross alpha, gross beta activity concentration as well as the annual effective committed dose due to consumption of the water from the different sources in the two districts of Mangu Local Government area of plateau state. The gross alpha activity concentration in the samples ranges from 0.0104± 0.002 Bq/L to 0.1381 ± 0.013 Bq/L. These values are much similar with those of (Gyuk*et al*., 2017 and Samson *et al*., 2018,) in well and borehole water ofChikunand Kaduna south Local Government area and Portable drinking water in Abuja,but lower than those anlyesdby (Lubis *et al*., 2019) in some mining Ponds water around Dorowa in BarkinLadi Local Government and also (Ezekiel *et al*.,2013) in Oil Fields Environment in Niger Delta of Nigeria. The results of the analysis were all below the WHO recommended value of 0.5Bq/L practical screening level. The gross beta activity concentration of the water analysis from the study area ranges from 0.0103 ± 0.014Bq/L to 0.1612 ± 0.029 Bq/L. these values were found to be similar to those obtained by (Gyuk*et al*.,2017) in some well and borehole water of Chikun and Kaduna south Local Government area.However, the result of the studies were below the WHO recommended limit of 1.0Bq/L. The entire annual effective committed dose calculated for both the alpha and beta activity was all below the ICRP acceptable limit of 0.1mSv/yr.

IV. CONCLUSION

The study of gross alpha and beta radioactivity indicates that the water samples under investigation have a low concentration of both alpha and beta emitters and the activity was less than 0.5Bq/L for alpha and 1.0Bq/L for beta. This shows that the radioactivity of the water samples from all the selected locations were well below the limit set by the WHO. The estimated committed effective dose to the different age groups in all the locations are below 0.1mSv/yr (ICRP, 1997) guideline value. The water can be said to be safe for consumption by the inhabitants

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