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# APPRAISING THE GROSS RADIOLOGICAL CONTENT OF UNDERGROUND WATER USE FOR DOMESTIC PURPOSES WITHIN AN ANCIENT TIN MINING VILLAGE IN BOKKOS LOCAL GOVERNMENT OF PLATEAU STATE, NIGERIA.

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**Abstract**

Water sources are often being polluted by some human activities and natural phenomena, thus adversely affecting the quality of water. Some of the pollutants are Naturally Occurring Radioactive Materials (NORMs). One water sample was collected from ten different wells within Butura Kampani. Each sample was taken in a two-liter plastic container. 10ml of concentrated Nitric acid was immediately added into each sample to prevent adhesion of radionuclides with the wall of the container. The samples were counted for gross alpha and beta activity concentration using a proportional counter (MPC 2000) at centre for energy research Zaria. The results obtained showed that gross alpha activity concentrations range from 0.0042±0.00093 Bq/L to 0.13406±0.00050Bq/L with an average value of 0.02714±0.00235Bq/L while the gross beta activity concentrations ranges from 0.01405±0.00245 Bq/L to 0.37883±0.02576Bq/L with an average value of 0.7439±0.00479 Bq/L. The results revealed that the gross alpha and gross beta activity concentrations are below the ICRP and WHO permissible limits of 0.5Bq/L and 1.0Bq/L respectively, for drinking water.

**Key words:** Tin mining, well water, gross alpha and gross beta concentrations, Butura Kampani,

## Introduction

Water is indispensable for plants and animals; hence water is life. However, water sources are constantly being polluted by human activities including tin mining which in turns adversely affect water quality. Gross alpha and gross beta particles activity concentration measurement in water reveals the total amount of radioactivity in the water sample attributable to the radioactive decay of alpha-emitting and beta-emitting radionuclides from the parent as uranium and thorium radionuclides. Uranium and Thorium are mostly NORMs and their concentration is more in underground water than in surface water (Gellermann, 2000). They contaminate the water body directly through their decay progenies and indirectly through the Radon and Thoron gaseous product which can solidify and attach themselves as aerosols to the air particles and are washed down by rain

into water bodies (Gellermann, 2000). Furthermore, flowing water encounters shelves sedimentary rocks, igneous rocks and phosphate rocks all of which are also radioactive, hence elevating the concentration level of radionuclides in the water. Furthermore, water pollution also arises from waste and sewage disposals from industries, hospitals and wash outs from fertilizers used by the farmers (Nwoke, 2006). Some of the pollutants are radionuclides (Alan and Samuel, 1992). Another source of water pollution arises from the secondary particles of cosmic radiation which release radionuclide into the atmosphere and this radionuclide are washed down by rain into ground and surface water bodies. Water sources are also polluted by the naturally occurring radioactive materials (NORMs) of the earth crust which emits alpha, beta and gamma radiations (Gellermann, 2000).

More worrisome is the fact that radionuclide in drinking water can easily be ingested into human beings resulting to internal exposure. Assessing gross alpha and gross beta activity concentration in water is appropriate as a preliminary screening procedure to determine the suitability of any water source for human consumption (Abdul *et al.,* 2016). Furthermore, gross alpha and beta activity measurement is used for detecting changes in the radiological characteristics of the drinking water source (WHO, 2011).

The concentration of gross alpha and gross beta in water bodies differ for various locations depending on geological composition of the soil and human activities around the water bodies. The gross alpha activity in water samples collected from abandoned mining ponds from Jos South Local Government Area (L.G.A) of Plateau State ranged from 0.006 ± 0.002 Bq/L to 0.144 ± 0.003 Bq/L with the mean of 0.0382 ± 0.007 Bq/L. The beta activity concentration ranged from 0.355 ± 0.330 Bq/L to 11.319 ± 0.519 Bq/L with the mean value of 1.721 ± 0.356 Bq/L (Daburrum *et al.*, 2015). Furthermore, gross alpha and gross beta activity concentrations in well water samples collected from Mangu L.G.A of Plateau State ranged between Bq/L to 7.668 ± 0.12 Bq/L with the mean of 0.869 0.13 Bq/L while its gross beta ranged from Bq/L to 1.379 ± 0.29Bq/L with their mean as 0.333 0.09 Bq/L (Daburrum *et al.*, 2015). The gross alpha and gross beta activities in most surface water sources within the Naraguta community of Jos North L.G.A of Plateau State were reported to be above the World Health Organization recommended safety limit values of 0.5Bq/L and 1.0 Bq/L for alpha activity and beta activity concentrations respectively (Mangset *et al.* 2015). Akpa *et.al* (2004) studied gross alpha and gross beta radioactivity concentrations in well water samples collected from Zaria town in Kaduna State Nigeria. He found that gross alpha activity ranges from 0.58 - 42.19 Bq/L; averaging at 6:35 ± 0.45 Bq/L while gross beta activity concentration ranges 3.58 - 622 Bq/L with an average value of 75.34 ± 1.53 Bq/L (Akpa, *et al.* 2004).

Butura Kampani is an ancient tin mining town situated within Bokkos L.G.A of Plateau State. The town is well known for irrigational farming and tin mining activities. Because of the rural nature of the town, the major source of drinking water is the well. Anthropogenic activities including mining and agriculture may further increase. Butura community has an approximate population of over ten thousand people. It also plays host to some students of plateau state University because of its proximity to the university.

Ingesting elevated levels of gross alpha can increase the risk of adverse health effects including bone and sinus cancer, anemia and kidney damage. Gross alpha and gross beta

are tasteless, colorless and odorless in drinking water, only testing can reveal their presence in drinking water. Therefore, this study aimed to measure gross alpha activity and gross beta activity concentrations in water samples collected within Butura Kampani to determine their fitness as drinking water.

**Materials and Methods**

Random selection method adopted from (IAEA,2003 and Williams 1997) was used to select the wells from where samples were collected. At each sampling site, water fetch from the well using drawer was transferred into a two-litter plastic container. Immediately after sampling, each sample was properly labeled and then acidified with 10 ml of concentrated Nitric acid to prevent absorption of radionuclides by the wall of the container.

The samples were transported to the laboratory and stored in a cold room prior preparation and analysis. Each sample was doubled filtered using a pressure filter. First through a 8μm pore size filter to remove foreign materials visible to the eye and secondly through a 0.45 μm pore filter to remove suspended materials not visible to the naked eye. The 0.45 μm size is regarded as the boundary for separating particles belonging to the solid phase (>0.45 μm) and those belonging to the liquid phase (IAEA,2003). The original sample container (now empty) was gently rinsed with de ionized water to clean it from any residue. The filtered water sample was return into the container and acidified with 4 ml of nitric acid ($HNO_3$, pH=2) per 2 litre of water. The samples were allowed to stay at least 24 hours before analysis. The acidification and waiting period were to ensure any absorbed element or nuclides on container walls are leached back into the water sample (Williams 1997).

About 500ml of each sample was measured into a well labeled ceramic furnace dishes, set on hot plate at a steady temperature and allowed to evaporate. The temperature used was below boiling point to avoid loss of much residue. Then about 77mg of the residue was weighed using digital analytical weighing balance and transferred into well labeled Planchet. Each sample was analyzed for gross alpha and gross beta activity concentration using a gas flow proportionality counter. Each sample was analyzed for 3hrs. Prior sample analysis, the detector was calibrated using **Sr-90** a beta source and **Pu -239** an alpha source. All the samples were prepared and analyzed at the Centre for Energy, Research and Training, Ahmadu Bello University Zaria, Kaduna State, Nigeria.

**Results**

The activity concentration of gross alpha and gross beta as measured from ten (10) different wells located at different distances within Butura Kampani are presented in Table 1 and labeled lot 1-10.

**Table 1.** Activity concentration of gross alpha and gross beta in well water.

| | | Activity concentration (Bq/L) | |
|---|---|---|---|
| **S/N** | **Sample I.D** | **Gross alpha** | **Gross beta** |
| 1 | Lot 1 | 0.00422 ± 0.00009 | 0.02082 ± 0.00196 |
| 2 | Lot 2 | 0.00588 ± 0.00130 | 0.01405 ± 0.00245 |
| 3 | Lot 3 | 0.27180 ± 0.00197 | 0.07355 ± 0.00407 |
| 4 | Lot 4 | 0.01826 ± 0.00158 | 0.03073 ± 0.00290 |
| 5 | Lot 5 | 0.01438 ± 0.00124 | 0.05133 ± 0.00272 |
| 6 | Lot 6 | 0.00977 ± 0.00062 | 0.01876 ± 0.00117 |
| 7 | Lot 7 | 0.13406 ± 0.01261 | 0.37883 ± 0.02576 |
| 8 | Lot 8 | 0.00458 ± 0.00050 | 0.02254 ± 0.00116 |
| 9 | Lot 9 | 0.02106 ± 0.00094 | 0.07265 ± 0.00221 |
| 10 | Lot 10 | 0.03204 ± 0.00183 | 0.06062 ± 0.00349 |

**Discussion**

Measuring gross alpha and gross beta activity concentration in water is a preliminary screening procedure which reveals the total activity of a sample without regard to the presences of specific radionuclide. For drinking-water, screening levels for which no further action is required are 0.5 Bq/L for gross alpha activity and 1.0 Bq/L for gross beta activity. If neither of these values is exceeded, the radiological dose of 0.1mSv/year will not be exceeded.

The gross alpha activity concentration in well water samples studied were found to range from 0.00422 Bq/L to 0.13406 Bq/L with an average of 0.02714 Bq/L while the beta concentration range 0.01405 Bq/L to 0.37883 Bq/L with an average of 0.7439 Bq/L. These values are within the same range as those obtained by Monday (2019) from different wells within this same study area (Monday 2019). In his study, Monday (2019) reported a gross alpha activity ranging from 0.14162 Bq/L to 0.81950 Bq/L and gross beta activity from 0.13796 Bq/L to 1.41127 Bq/L (Monday, 2019).

It is interesting to state the fact that samples, Lot 2, Lot 4, Lot 6 and Lot 8 located inside residential compounds showed lower activity concentration compared to Lot 3, Lot 5, Lot 7 and Lot 9 which are situated within potato farmlands around Butura. This variation may be attributed to leaching from chemicals and fertilizer used on the farm overtime.

The highest alpha and beta concentration was found to be in the water sample from the Lot 7 (see Figure 1). This high activity concentration may be attributed the close proximity of Lot 7 to an abandoned mining pound. Furthermore, it suggests that the radionuclide within the Butura Kampani area decay by emitting mostly beta particles as suggested by the higher gross beta activity concentration in all the samples studied except in Lot 3.

However, the water samples collected from all the ten (10) wells reveals a gross alpha and gross beta activity concentration values below the permissible safety limits values of 0.5 Bq/L for alpha activity and 1.0 Bq/L for beta activity concentration as recommended by the International Commission on Radiological Protection (ICRP, 1991) and the World Health Organization (WHO, 2011).

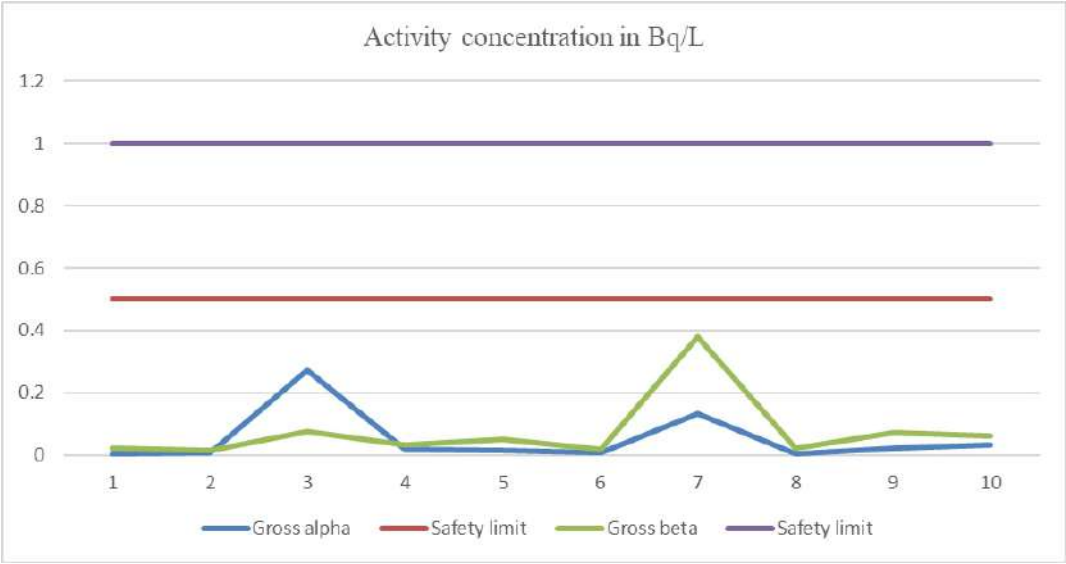


Figure 1 Comparison of activity concentration from various wells.

Although the results obtained from this study compare favorably with those reported by Monday (2019) from Butura community of Bokkos L.G.A (Monday,2019) however, they are lower than what was reported by Daburrum *et al.* (2015) from Mangu L.G.A (Daburrum *et al.* 2015) and Mangset *et al* (2015) from the Naraguta community of Jos North L.G.A (Mangset *et al* 2015). Furthermore, a comparison of gross alpha and gross beta activity concentration from different locations in Nigeria is presented in Table 2.

Table 2: Comparison of gross alpha and gross beta activity concentration from different locations in Nigeria.

| | Activity concentration (Bq/L) | | | | |
|---|---|---|---|---|---|
| | Gross Alpha | | Gross beta | | |
| **Study area** | **Min** | **max** | **Min** | **Max** | **Source** |
| Kaduna North | 0.001 | 0.014 | 0.286 | 9.510 | (Abdul, 2016) |
| Western Niger Delta | 0.010 | 0.700 | 1.100 | 13.200 | (Asibor, 2019) |
| Jos North | 0.050 | 6.640 | 0.010 | 6.680 | (Mangset, 2015) |
| Kaduna River | 0.012 | 0.087 | 0.064 | 2.679 | Nwoke J. E. 2006) |
| Butura | 0.142 | 0.820 | 0.138 | 1.411 | (Monday 2019) |
| Zaria | 0.580 | 42.190 | 3.580 | 622.000 | (Nwoke J. E. 2006) |
| Butura Kampani | 0.004 | 0.134 | 0.0141 | 0.378 | This research work |
| | | 0.50 | | 1.00 | (ICRP, 1991) |

**Conclusion**

Preliminary screening for gross alpha and gross beta activity concentration in water samples collected from Butura Kampani brought to light the fact that activity concentration is higher in well situated within farmlands than those within houses. Radionuclides around Butura decay by emitting mostly beta particles as suggested by the higher gross beta activity concentration in all the samples studied except in Lot 3. However gross alpha and gross beta activity concentration values in well water within this study area are below the permissible safety limits values of 0.5 Bq/L for alpha activity and 1.0 Bq/L for beta activity concentration as recommended by the International Commission on Radiological Protection (ICRP, 1991) and the World Health Organization (WHO, 2011). Since neither of these values is exceeded, the radiological dose of 0.1mSv/year will not be exceeded hence safe for consumption.

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