

## Determination of Gross Alpha and Beta Activity in Water: (A Case Study of Gombe Metropolis)

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**Abstract:** A study on the “Determination of Gross Alpha and Beta activity in Water” in Gombe metropolis was carried out. Nuclides are unstable elements that are spontaneously emitting nuclear radiation in an attempt to attain the nuclear structure of the stable elements. Human exposure to these radiation beyond certain limit can cause serious health problems. Radionuclides can be found in air, water and soil. This study investigated the gross alpha and beta activity in water from Gombe metropolitan. Gross alpha and beta activity is a measure of the total amount of natural radioactivity in a water sample attributable to the radioactive decay of alpha or beta particles emitted from natural decay series. The gross alpha and beta activity is used to create assurance on the level of nuclear contamination in water for drinking and other domestic use. The World Health Organization (WHO) standard for alpha and beta activity in water 100 Bqm<sup>-3</sup>. The results obtained in this study varies between 0 – 0.045 Bq/I and 0.659 – 11.580 Bq/I for alpha and beta radiation respectively. Comparison of these results with the WHO standards shows that the gross alpha and beta activity in the water in Gombe metropolitan is far below WHO standards. This indicates the safety of the water in the study area for drinking and other domestic applications.

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### 1.0 Background of the Study

Gross alpha and beta particles activity is a measure of the total amount of natural radioactivity in water sample attributable to the radioactivity decay of alpha and beta emitting from natural decay series. Gross alpha and beta radiation measurement is not a nuclide specific measurement, but is used to create awareness of the level of contamination especially in drinking water. It is also recommended test of drinking water quality. The WHO limits for gross alpha activity on drinking water is 100 Bqm<sup>-3</sup> and 1000 Bqm<sup>-3</sup> for gross beta activity (WHO, 2003). Above these limits, specific radionuclide test is recommended as it is more important for later purification of the water if need be. There is a significant hazard in drinking water containing excess activity to both individuals and to a population, thus gross alpha and beta radiation measurement have been conducted in European countries as routine environmental radioactivity measurements, (CEC, 1982). In the United States of America, there also exist legislative limits for gross alpha/beta activity in drinking water (USGS, 2000). In other countries and regions of the world, a lot of research efforts have been directed to this measurement.

In Nigeria, not much research have been done on the radiological quality of drinking water and this may be as result of low level of development of the nuclear industry in the country. Gross alpha and beta radioactivity measurement involves the use of low-level background proportional centre system. This system is available in the centre for energy Research and Training, Zaria. (Akpa, et al, 2004). In this work, we report the result of gross alpha and beta radioactivity in water from Gombe metropolitan. The aim is to compare the levels measured with values applicable in other regions of the world.

Radioactivity is a statistical process describing the spontaneous transformation unstable atomic nuclei (called parent nuclei) into a more stable configuration (called nuclei) without effect of physical and chemical condition. In a case where the daughter product is also unstable, the decay process carries on until daughter nucleus reaction stability. Consequently, the energy of the transformation of the can be released by the emission of nuclear particles and /or in terms of electromagnetic radiations. The strength or intensity of the radioactivity is called the activity

and is defined as the rate of nuclei number decaying.

### 1.2 Aim and Purpose of the Study

Human exposure to nuclear radiation beyond certain limit can be very hazardous. The aim of the study is to obtain the gross alpha and beta radioactivity in drinking water in Gombe metropolitan to ascertain it's safety for human consumption . The objectives of this work are to:

- i. Determine the radionuclides in the water samples of Gombe metropolis
- ii. Determine the radioactivity of gross alpha and beta in water samples collected from various locations within Gombe metropolis.
- iii. Compare the result obtained with world Health organization standard (WHO).

### 1.3 Significance of the Study

The importance of water in human life cannot be over emphasized because water breeds life. There is need for the general public to know the nature of the water they consume daily. The research tends to find out the gross alpha and beta radioactivities in water in Gombe metropolis and to compare the results obtained from the analysis with the world health organization standard limit of 100 Bqm<sup>-3</sup> and 1000 Bqm<sup>-3</sup> for gross alpha and beta activity in drinking water. This will prevent the hazard due to nuclear radiation in drinking water (WHO, 2003).

### 1.4 Statement of the Problem

Human exposure to nuclear radiation beyond certain limit can be very hazardous. The aim of the study is to obtain the gross alpha and beta radioactivity in drinking water in Gombe metropolis to ascertain its safety for human consumption. The sources of water for drinking and other domestic activities in Gombe metropolis are wells, boreholes, and the Dadin Kowa dam. These water sources are susceptible to pollution from nuclear radioactivity such as the gross alpha and beta activity, hence the dire need for a study such as the one undertaken by the researchers.

## 2.0 Materials and Method

### 2.1 Introduction

This section presents the procedures adopted for data sampling, sample preparation, measurement, instruments and data analysis and interpretation.

### 2.2 Samples Collection

Samples of consumable water from various locations in Gombe metropolis were randomly obtained from ten (10) sampled regions which are:  
SAMPLE 1: Gombe High School behind Government House (Reservoir)  
SAMPLE 2: F C E (Tech) Gombe, Dukku Road (Tap water)

SAMPLE 3: Tudun Wada Pantami (Behind Goje's House, Dam reservoir)

SAMPLE 4: Jekadafari near Cross (Borehole)

SAMPLE 5: Buhari Estate (Tap water)

SAMPLE 6: New GRA (Tap water)

SAMPLE 7: Govt Science Secondary School (Borehole)

SAMPLE 8: Water Board (Tap water)

SAMPLE 9: Federal Lowcost Gombe (Tap water)

SAMPLE 10: Buba Shongo (Reservoir)

At each sampling point, one sample of water upto 200 g was collected. The following precautions was taken into consideration during the samples collection:

- i) Cleanliness of the instruments used was ensured against any possible contaminants,
- ii) Care was taken to obtain water void of contamination,
- iii) Samples were collected from locations within the study area, and
- iv) All the samples collected were labelled and stored in clean plastic bottles that were in turn put in a polyethylene bags to minimise radiation exposure level during transportation.

### 2.3 The Study Area

The study was specifically carried out in Gombe metropolis (Buba Shongo, Federal owcost, F.C.E. (Tech.) Gombe, Jekadafari, Tudun wada Pantami, Gombe High School, Buhari Estate, New GRA, Government Science Secondary School, Gombe and Water Board), in Gmbe Local Government Area, of Gombe State.

Gombe State, which was created on October 1, 1996, is located in the northeast geo-political zone of Nigeria. It is bounded in the north by Yobe State, in the south by Taraba and Adamawa States, in the east by Borno State and in the west by Bauchi State. It has a population of about 2.4 million people (NPC, 2006) and occupies a total landmass of 20,265 km<sup>2</sup> , State Economic Empowerment and Development Strategy (SEEDS, 2006).

Gombe State located on latitude 10.29°N (10.25°N), 11.10E (11.17E) and longitudes 8.36°W (8.42°W) and 8.46°S (8.67°S) with a mean temperature of 25.4°C annually.

### 2.4 Sources Of Radiation In Water, Air And Soil

Naturally occurring radiation can be found all around us. Radiation can be found in soil, in our air and water and in us. Because it occurs in our natural environment, we encounter it every day through the food we eat, the water we drink and the air we breathe. It is also in building materials and items we commonly use.

There are three groupings of naturally occurring radiation, mostly based on where the radiation comes from:

- a) There is radiation in the soils and rocks, called primordial or terrestrial.
- b) There is radiation that comes from space, called cosmic or Cosmo genic and
- c) There is human made radiation:- This is created by humans that wouldn't exist otherwise or something that contains more radiation in it than normal (enhance) because humans have done something to it.

### 3.0 Samples Preparation and Experimental Procedures

To prepare the sample, evaporation was done on each sample using hot plate without stirring in open 50 ml beakers for an average of 54 hours. The residue obtained was washed with distilled water and transferred into 7.1 cm<sup>2</sup> counting planchet with the help of a rubber policeman. The sample was completely dried on the planchet under room temperature. The sample preparation efficiency was obtained from the equation proposed by Tijjani and Zakari, (2015).

#### 3.1 Data Analysis

$$\text{Sampling efficiency} = \frac{((B + S - WB) - (WB - S - WB))}{(WB + S - WB)} \quad (1)$$

where WB = weight of the beaker  
 WB+ S = the weight of the beaker and sample  
 Wb - S= weight of the beaker after sample was recovered from it.

#### 3.2 Calculation of Gross Alpha And Beta Activity in The Samples

The gross alpha and beta activity in the sample was calculated using the equation (2) as:-

$$\text{Activity } (\alpha, \beta) = \frac{\text{Rate}(\alpha, \beta) - \text{bdg}(\alpha, \beta)}{\text{sample efficiency} \times \text{chenel efficiency} \times \text{volume}} \quad (2)$$

where Bgd (α,β) = background radiation

$$\text{raw } (\alpha, \beta)$$

$$\text{Rate } (\alpha, \beta) = \text{Raw } (\alpha, \beta) \text{ count} = \frac{\text{raw } (\alpha, \beta)}{\text{count time}} \quad (3)$$

The statistic appreciation is calculated for each channel, on each, measurement and it depends only on the preset count whose value is declared indirectly. For N measurement in a time T, the average is given by the equation below:

$$\bar{x} = \frac{\sum xn}{N} \quad (4)$$

And the standard deviation is given by the equation (5)

$$s \approx \sqrt{x} \quad (5)$$

(Tijjani and Zakari, 2015).

### 4.0 RESULTS AND DISCUSSION

In this chapter, the results of the ten (10) samples analysis of the Gross alpha and beta activity in water from the ten (10) locations within Gombe Metropolis are presented in table 4.1.

#### 4.2 The results

The result of the gross alpha and beta activity in the water sample collected from different locations in Gombe Metropolitan are shown in table 4.1. The errors quoted are standard deviations. The results obtained show that the gross alpha and beta activity in the samples vary between 0 - 0.045 Bq/l and 0.689 - 11.580 Bq/l respectively. These results indicates the safety of the water in the area for drinking and other domestic use since the activity are far below World Health Organization (W H O) standard of 100 Bq/m<sup>3</sup> and 1000 Bq/m<sup>3</sup> for alpha and beta respectively. Similar study was carried out on water in various sources of water in Bauchi and its environs by Tijjani A. M and Zakari, A. (2015). They found that the gross alpha and beta activity vary between 0 - 0.049 Bq/l and 0.798 - 10.590 Bq/l for alpha and beta activities respectively.

#### 4.3 The results obtained using the procedures outlined are shown in Table 4.1

Table 4.1: Results of gross alpha and beta activity from ten locations in Gombe Metropolis

S/No.	Samples	Locations	Alpha Activity Bq/l	Beta Activity Bq/l
i.	1	Gombe High Sch. Reservoir	0.00 ± 0.005	10.490 ± 0.246
ii.	2	F.C.E (T) Gombe Tap water	0.030 ± 0.011	6.340 ± 0.310
iii.	3	Pantami Reservoir	0.018 ± 0.003	0.689 ± 0.149
iv.	4	J/Fari Borehole	0.00 ± 0.005	11.580 ± 0.337
v.	5	Buhari Estate G.R.A Tap water	0.023 ± 0.012	6.560 ± 0.430
vi.	6	New G.R.A Tap water	0.27 ± 0.010	7.430 ± 0.350
vii.	7	G.S.S.S. Gombe Borehole	0.031 ± 0.013	0.890 ± 0.134
viii.	8	Water Board Tap water	0.039 ± 0.08	10.309 ± 0.230
ix.	9	F/Low coast Tap water	0.040 ± 0.006	11.080 ± 0.440
x.	10	Buba Shango Reservoir	0.045 ± 0.014	8.980 ± 0.390

#### 4.4 DISCUSSION

**Samples 1 and 4:** from Gombe High School (reservoir) and J/Fari (Borehole) have the same values of alpha activity of  $0.00 \pm 0.005$  Bq/I each but varied in beta activity of  $10.490 \pm$  to  $246$  Bq/I.  $11.580 \pm 0.337$  Bq/I respectively.

**Sample 2:** From F.C.E (T) Gombe location is tap water from Dadinkowa dam has the variation of alpha and beta activities of  $0.030 \pm 0.011$  Bq/I and  $6.340 \pm 0.310$  Bq/I respectively.

**Sample 3:** From Pantami Tudun wada location, is reservoir which has the variation of alpha and beta activity of  $0.018 \pm 0.003$  Bq/I and  $0.689 \pm 0.149$  Bq/I respectively.

**Sample 5:** From Buhari estate GRA location, the source is tap water channel from Dadinkowa dam which has the variation of alpha and beta activity of  $0.023 \pm 0.012$  Bq/I and  $6.560 \pm 0.430$  Bq/I respectively.

**Sample 6:** Is gotten from the New GRA and the source is tap water and the values of alpha and beta activities are  $0.27 \pm 0.010$  Bq/I and  $7.430 \pm 0.350$  Bq/I respectively.

**Sample 7:** From GSSS. Gombe location and the source is borehole the value of alpha and beta activities obtained from the analysis are  $0.031 \pm 0.013$  Bq/I and  $0.890 \pm 0.134$  Bq/I respectively.

**Sample 8:** Is obtained from water board and the source is tap water, the results obtained are  $0.039 \pm 0.08$  Bq/I and  $10.309 \pm 0.230$  Bq/I respectively.

**Sample 9:** Is from federal low-cost and the source is tap water and the results obtained from the analysis are  $0.040 \pm 0.006$  Bq/I and  $11.080 \pm 0.440$  Bq/I respectively.

**Sample 10:** Is obtained from Buba Shongo location and the source of water is reservoir. The values obtained from the analysis are  $0.045 \pm 0.014$  Bq/I and  $8.980 \pm 0.390$  Bq/I respectively.

#### 5.0 Conclusion and Recommendations

In this section, the conclusion and recommendations are presented. The sources of nuclear radiation in an environment are the radionuclide (Dyson, 1993). These are the unstable elements which are spontaneously emitting radiation in an attempt to attain the nuclear structure of the stable elements radionuclide can be found in air, water and soil. Radionuclide are very useful in various fields such as medicine, agriculture and engineering fields (Wang and Willis, 1975). Human exposure to nuclear radiation beyond certain limit can cause serious health problems.

Gross alpha/beta particles activity is a measure of the total amount of natural radioactivity in a water sample attribute to the radioactive decay of alpha or beta emitting from natural decay series. Gross alpha and beta radiation measurement but is used to create awareness of the level of contamination especially in drinking water (Onoja et al, 2007).

#### CONCLUSION

The result obtained revealed that alpha and beta activity in water collected within Gombe Metropolitan is below the World Health Organization (WHO) standard. Judging from the alpha and beta activity values obtained in this research, it is concluded without any prejudice that it is safe to drink and utilize the water for domestic activities.

#### RECOMMENDATIONS

Due to the difficulty encountered in the course of the study, the following recommendations are suggested for further studies:

- The State and Federal government own tertiary institutions in Gombe State should come together to establish a research and training center where these types of analysis can be done,
- The State Ministry Water Resources should have a research center where gross alpha/beta particles are analyzed to avert the risk of contracting some of these water related diseases by the people, and
- The research on the gross alpha and beta activity in water should be extended to the rural and remote areas to know the level of gross alpha and beta particles (Nuclear radiation) in the water the people consume.

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