Evaluation of Gross Alpha and Gross Beta Activity Concentrations In Some Well Water at Butura Kampani Community of Bokkos Local Government, Plateau State

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ABSTRACT: Sources of water are always 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 to the wall of the container. The samples were counted for gross alpha and beta activity using a proportional counter (MPC 2000). The results obtained showed that gross alpha activity concentrations range from 0.00422 ± 0.00093 Bq/l to (0.13406 ± 0.00050) Bq/l with an average value of 0.02714 ± 0.00235 Bq/l while the gross beta activity concentrations ranges from 0.01405 ± 0.00245 Bq/l to 0.37883 ± 0.02576 Bq/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.

Keywords: gross alpha, gross beta, concentration, radiation, well water,

INTRODUCTION

Clean water is very essential for human existence. However, water sources are constantly being polluted by some human activities and natural phenomena; thus adversely affecting the quality of water. Water pollution arises from waste and sewage disposals from industries, hospitals and wash outs from fertilizers used by the farmers [1, 2]. Some of the pollutants are radionuclides [1, 2]. 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 [3].

Uranium and Thorium are mostly NORMs and their concentration is more in underground water than in surface water [3]. 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 [3]. 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.

Radionuclide in drinking water can easily be ingested into human beings resulting to internal exposure. Hence, assessing gross alpha and gross beta activity concentration in water is appropriate as a preliminary screening procedure towards determining the suitability of any water source for human consumption. Furthermore, the gross alpha and beta activity measurement is used for detecting changes in the radiological characteristics of the drinking water source [4, 5].

Butura Kampani community of Bokkos L.G.A of Plateau State is known with farming and tin mining activities well water is the major source of drinking water within this community. However, the ground water within Butura Kampani may be contaminated with radionuclides as a result of anthropogenic activities including mining and agriculture. Furthermore, the proximity of Butura Kampani to Plateau State University Bokkos, made the community a host to many university students who could not secure accommodation in the university

hostels. Considering the health effect of radionuclides when ingested into humans, it is essential to assess the levels of gross alpha and gross beta activity concentrations in well water within Butura Kampani.

This study aimed at assessing the levels of gross alpha and gross beta activity concentrations in ground water samples collected from Butura Kampani community in order to determine their suitability for human consumption.

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 [6].

Similarly, Daburum *et al.* (2015) reported that gross alpha and gross beta activity concentrations in well water samples collected from Mangu L.G.A of Plateau State ranged between 0.028 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 0.041 Bq/l

to 1.379 ± 0.29 Bq/l with their mean as 0.333 ± 0.09 Bq/l [6].

However, 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 0.5 Bq/l and 1.0 Bq/l for alpha activity and beta activity concentrations respectively [7].

Again, 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 [8]

METHODS

Random selection method adopted from [9,10] was used to select the wells from where samples were collected. At each sampling site, water fetched from the well using a bucket was transferred into a two-liter plastic container (see Plate 1a.) 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.

Plate 1 Photographs showing Sample

Plate 1b. Prepared sample

Plate 1c. Sample in a detector

Collection, Preparation and Detection of Activity Concentration

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 8 μm 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 ($>0.45 \mu\text{m}$) and those belonging to the liquid phase [11]. 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 , $\text{pH}=2$) per 2 liter of water. The samples were allowed to stay at least 24 hours before analysis. The acidification and waiting period was to ensure any absorbed element or nuclides on container walls are leached back into the water sample [11].

About 500 ml 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 77 mg of the residue was weighed using digital analytical weighing balance and transferred into well labeled Planchet (see Plate 1b). Each sample was analyzed for gross alpha and gross beta activity concentration using a gas flow proportionality counter (Plate 1c). Each sample was analyzed for 3 hrs. 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 gross alpha and beta radioactivity concentrations for water samples collected from ten (10) different wells within Butura Kampani community are presented in Table 1.

Table 1 Gross Alpha and Gross Beta Activity Concentrations in Water from selected Wells within Butura Kampani.

S/No	Sample ID	Alpha Concentration (Bq/l)	Beta Concentration (Bq/l)
1.	Well 1	0.00422 ± 0.00009	0.02082 ± 0.00196
2.	Well 2	0.00588 ± 0.00130	0.01405 ± 0.00245
3.	Well 3	0.27180 ± 0.00197	0.07355 ± 0.00407
4.	Well 4	0.01826 ± 0.00158	0.03073 ± 0.00290
5.	Well 5	0.01438 ± 0.00124	0.05133 ± 0.00272
6.	Well 6	0.00977 ± 0.00062	0.01876 ± 0.00117
7.	Well 7	0.13406 ± 0.01261	0.37883 ± 0.02576
8.	Well 8	0.00458 ± 0.00050	0.02254 ± 0.00116

9.	Well 9	0.02106 ± 0.00094	0.07265 ± 0.00221
10.	Well 10	0.03204 ± 0.00183	0.06062 ± 0.00349

DISCUSSION

Gross alpha and gross beta activity measurement is the radioactivity measurement which reveals the total activity of a sample without regard to specific nuclide. 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 ranges from 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 around Butura community [12]. In his study, Monday (2019) reported that gross alpha concentration varied from 0.14162 Bq/l to 0.81950 Bq/l and gross beta concentration varied from 0.13796 Bq/l to 1.41127 Bq/l [12].

The activity concentrations of the ten samples studied were graphically compared in Figure 1. Samples collected from, well 2, well 4, well 6 and well 8 which are located inside residential compounds showed lower activity concentration compared to well 3, well 5 well 7 and well 9 which are located

precisely inside potato farm lands within the community. This variation may be as a result of 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 well 7 as clearly seen from Figure 1. This high activity concentration may be attributed the close proximity of well 7 to an abandoned mining pond. The graph in Figure 1 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.

Figure 1. Graphical Comparison between the Levels of Alpha Concentration and Beta Concentration from the Samples of Ten Wells.

The highest gross alpha and gross beta concentration was found to be in the water sample from the well 7. However, as seen from Figure 2 all the concentration values obtained are lower than 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) [13] and the World Health Organization (WHO) [4]

Figure 2. Comparison of Activity Concentrations in Bq/l with Safety Limit

The results obtained from this study were compared with those from other studies conducted within Plateau State Nigeria. The results were found to be similar to those

reported by Monday (2019) from Butura community of Bokkos L.G.A [12], but much lower than what was reported by Daburru

et al. (2015) from Mangu L.G.A [6] and Mangset *et al* (2015) from the Naraguta community of Jos North L.G.A [7].

Furthermore, Table 2 shows comparison of our results with other results obtained from similar studies conducted outside Plateau State.

Table 2. Activity Concentration of Gross Alpha and Gross Beta Activity Concentration obtained from different Location in States within Nigeria.

Measured activity concentration (Bq/l)					
Location	Alpha		Beta		Source
	Minimum	Maximum	Minimum	Maximum	
Kaduna North	0.001	0.041	0.286	9.510	[5]
Western Niger Delta	0.010	0.700	1.100	13.200	[14]
Naraguta Street 108	0.050	6.640	0.010	6.680	[7]
Plateau State	0.140	4.310	0.040	1.170	
Kaduna River	0.012	0.087	0.064	2.679	[1]
	0.006	0.083	0.017	3.097	
	0.013	0.057	0.031	1.795	
Butura	0.142	0.820	0.138	1.411	[12]
Zaria	0.580	4.219	3.580	622.000	[8]
Butura Kampani	0.004	0.134	0.0141	0.378	This research work

CONCLUSION

The highest gross alpha and gross beta concentration was found to be in the water sample from the well 7. However, the selected samples studied were found to have gross alpha and gross beta activity concentration lower than 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 and the World Health Organization.

Therefore, water from most wells within Butura Kampani of Bokkos Local Government Area are currently safe for consumption in terms of radiation and required no further analysis for specific nuclides identification. Furthermore, the radionuclide within this study area decay by emitting mostly beta particles than alpha particles as suggested by the higher gross beta activity concentration in all the samples studied.

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