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An Assesement of Alpha Radioactivity Concerntration of Groundwater in Kakuri, Kaduna South Local Government Kaduna, Nigeria

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Abstract: Pollution is a global problem; of the various forms of pollution, water pollution is probably one of the most important because of it health hazards. Water pollution is the contamination of the water bodies such as lakes, rivers, ocean and underground water by human or natural activities that constitutes a great deal of danger to both plants, animals and man. This could be from activities such as wrongful disposal of sewage, petroleum and refinery wastes, mining wastes, radioactive substances and toxic chemicals and application of nitrates and phosphates fertilizers. The focus of this paper is to determine the level of alpha radioactivity in underground water in kakuri Kaduna south Local Government Area Council of Kaduna state, Nigeria, located within latitude $10^{o}28^{1}0^{11}$ and longitude $7^{o}25^{1}0^{11}$ covering 59 km^2 with population of 402,390 by the 2006 census. Five [5] hand dug wells and five [5] boreholes were sampled and analyzed using the portable single channel Gas free MPC2000b-DP detector. The result shows that the range of alpha activity varied from 0.014±0.006 Bq/L to 0.072±0.008 Bq/L with a mean value of 0.037±0.014 Bq/L. This result shows that the alpha activity was far below the recommended value set by world health organization [WHO] which is 0.5 Bq/L per year. Therefore if the water from this samples point is consumed, it poses no threat to the health of the people around the area.

Keywords: Alpha activity, Borehole, Kaduna, Kakuri, Hand dug well, Radioactivity

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1. Introduction

The aim of this work is to analysis the concentration of alpha particles in water samples using the proportional counter to determine the alpha activity levels in hand dug wells and boreholes in Kakuri, Kaduna south Local Government Kaduna, Nigeria. Most of the sources of water supply in Nigeria are upland surface water or groundwater from boreholes and hand dug wells. Groundwater is the water located between the earth surface in soil pores and in the fractures of rock formation (1,2). A unit of rock or an unconsolidated deposit is called an aquifer, when it can yield a usable quantity of water. Groundwater is recharged and eventually flows to the surface naturally (3). This water might contain radionuclides which may be natural or artificial. Naturally occurring radioactive materials [NORM] are found almost everywhere and are inherent in many geologic materials; consequently it is encountered during geological related activities. The earth's crust contain naturally occurring radioactive materials (terrestrial radioactivity), and of most concern are uranium series, thorium series and their progeny [radon and thoron] which increases with depth (4). Because of this, drinking water from deep wells and boreholes is likely to contain a higher concentration of radioactive elements than surface water (5). Spring or flowing water, passes through rocks that may contain radioactive materials and it could be transported into wells, boreholes and taps water through burst pipes. Important radionuclides in drinking water are tritium, potassium-40, radium and radon, which are alpha, beta and gamma emitters (5). The beta activities measured could be from one of the following major sources; anthropogenic

factor [i.e. the atmospheric fall-out], deposition of radionuclide into the soil as a particle or dissolved nutrient and primordial sources as a result of rocks/hills in an environment. Radionuclide may be deposited into the soil either as particles or dissolved into soil water through the application of fertilizers and composite manure (6). These radionuclide, when absorbed by the root as nutrient will be translocated into various parts of boreholes and wells (7). The transfer of radionuclide from soil to water channels depends on the types of soil and water samples. Mobility of the radionuclide is another important factor responsible for the concentration (8,9). The atmospheric fall-out sometimes contributed immensely to the water concentration measured. This normally occurred as a result of nuclear disaster like disposal of radioactive waste material into the river. Radionuclide particles suspended in air could be deposited on the soil surface which later dissolved and the level of contamination therefore depends on the surface area of the water.

2. Materials and Method

Kaduna South is one of the Local Government Councils in Kaduna State, Nigeria, Kaduna is located between latitude$10^{o}20^{1}$N and $10^{o}33^{1}$N and longitude $7^{o}45^{1}$E and $7^{o}75^{1}$E, and has an area of 46.053km^2 and a population of 6,066,562 by the 2006 census. The materials that were used for this research work are: Syringe, Planchettes, Acetone, Cotton wool, Weighing balance, Infrared radiator, MPC 2000 B-DP [Dual Phosphor], Vinyl acetate, Concentrated trioxonitrate(v) acid [nitric acid], Spatula, Ceramic dish. The method applied to this sampling is the stratified random sampling technique. The map is grid into five locations, two samples were obtained from each location: one from hand dug well and one borehole source which gives a total of ten samples, in kakuri area in Kaduna south of Kaduna state, these locations includes: samara road, Faskere Street, Zango Street, Galadimawa Street and transformer junction. The sampling procedure is in accordance with international standard organization [ISO-5667-3]. At every point of sample collection the container is first rinsed twice before the water is put in the plastic container and concentrated trioxonitrate (v) acid [nitric acid] is added [10ml/2 litres]. The reason for this addition is, to lower the PH of the water to prevent microbial activities, prevent precipitation and absorption of the sample by container walls. The water samples were transferred to 100 ml beaker and evaporation was done using hot plates without stirring. It took an average of 24hrs to complete the evaporation of 1litre of the water sample. When the sample is almost dried up [about 50ml], It then transferred to the ceramic dish [which is sterilized to avoid cross contamination] and the dish placed under an infrared radiator at about 65^{o}C until it completely dried and weighed to obtain the weight of the residue. Then 77mg [0.077g] of the residue transfer into a sterilized planchette using a spatula and then weighed. The residue then uniformly spread on the planchette to obtain a uniform surface area of the sample for effective detection of the activities of the samples [vinyl acetate added in order to bind the particles together and remove any moisture content]. Sterilizations were done using acetone to avoid contamination of any form.

2.1 Gross Alpha Counting

High voltage for gross alpha counting was set at 1650V and samples were counted for 5 cycles of 2700 sec per cycle. The alpha count rates as well as alpha activity were calculated using the formula (10).

$$\text{Count Rate } (\alpha) = \frac{Raw\ (\alpha)\text{Count X } 60}{Count\ Time} \qquad 1$$

$$\text{Activity } (\alpha) = \frac{Rate\ (\alpha) - \text{Background Count } (\alpha)}{SE\ X\ CE\ X\ V} \qquad 2$$

Where: SE = Sample Efficiency; CE = Chanel Efficiency;

V = Volume of Water Sample

Alpha activity

The alpha activity is expressed as activity concentration C in Becquerel per liter [Bq/L]. The activity concentration was calculated using the formula (10)

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$$C = \frac{(R_b - R_0) \times a_s \text{ x m x } 1.02}{(R_s - R_o) \times 1000 \times v} \qquad 3$$

Where;

R_b is observed sample count rate (S^{-1})

R_s is observed standard count rate (S^{-1})

R_0 is background count rate (S^{-1})

a_s specific activity of the standard solid

V is volume of sample in liters,

And m is mass in milligrams of ignited residue from volume V.

It is important that the factor 1.02 be included in the final equation to correct for the 20ml of the nitric acid added to the sample as a stabilizer (10)

3. RESULT AND DISCUSSION

The values and associated errors in the concentration of the ten samples used for the gross alpha counting in each water sample according to the locations are presented in table 1.

The detector used is protean instrument corporation [PIC] MPC 2000 DP [dual phosphor] and the calibration sources used are: PU-239 an alpha source. Table 1 shows results of gross alpha radioactivity of the 10 water samples. The alpha detection limit is 0.14cpm

Table 1: Alpha Radioactivity in Water Samples

Sample identification	Alpha concentration (Bq/l)
N10 Hand Dug Well	0.052 ± 0.008
N12 Hand Dug Well	0.042 ± 0.017
N14 Hand Dug Well	0.021 ± 0.010
N24 Hand Dug Well	0.031 ± 0.016
17 Zango Hand Dug Well	0.055 ± 0.022
Galadimawa Borehole	0.072 ± 0.022
Ebenezer Borehole	0.014 ± 0.006
St. Andrew Borehole	0.020 ± 0.012
G17 Zango Borehole	0.036 ± 0.014
Transformer Borehole	0.027 ± 0.013
Average	0.037 ± 0.014

Source: Field Survey, 2015.

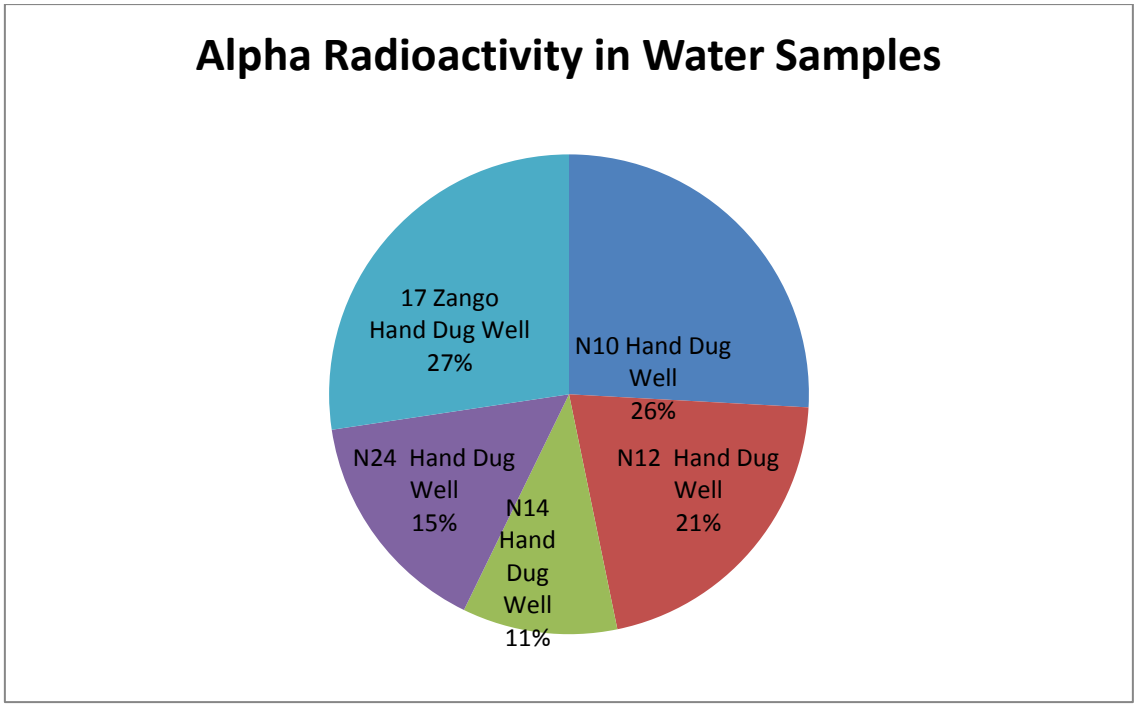

Fig 1: Pie chart showing alpha concentration in Bq/L in hand dug well

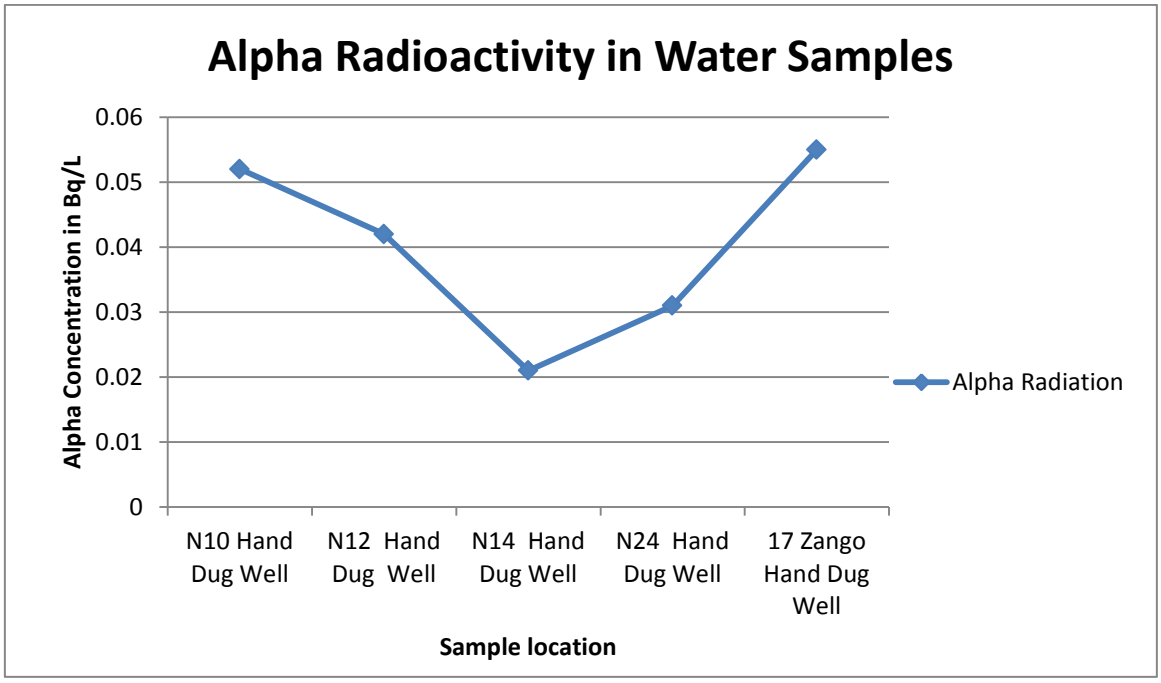

Fig 2: Line graph showing alpha concentration in Bq/L in hand dug well

The distribution of the activities of alpha concentration in hand dug well water samples ranged from 0.021±0.010 Bq/L in N14 well to 0.055±0.022 Bq/L in N17 Zango well, the mean value of alpha activity in hand dug well is 0.040±0.015 Bq/L, as shown in figure 1 pie chart and line graph in figure 2

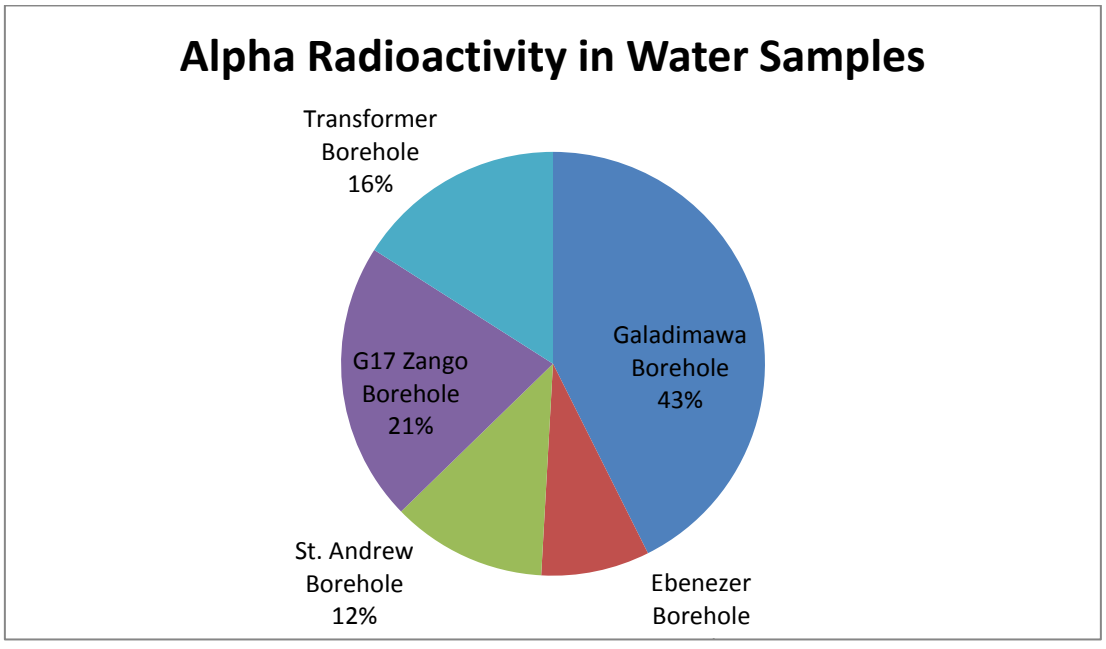

Fig 3: Pie chart showing alpha concentration in Bq/L in Borehole

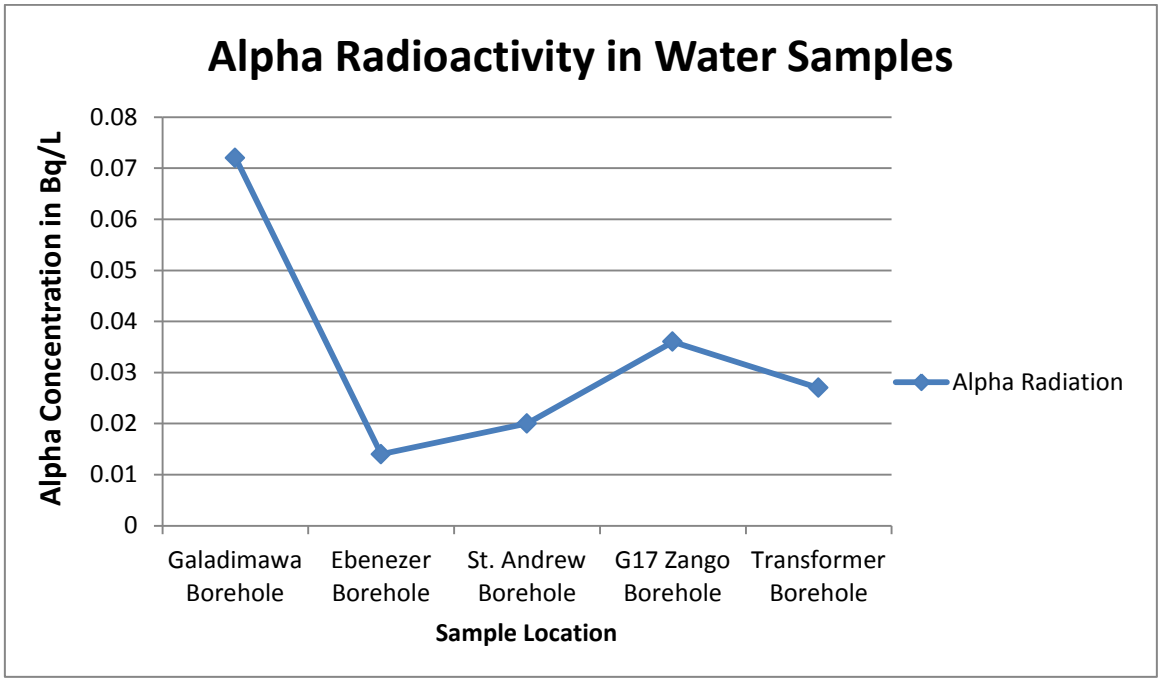

Fig 4: Line graph showing alpha concentration in Bq/L in Borehole

The distribution of the activities of alpha concentration in borehole water samples ranged from 0.014±0.006 Bq/L in Ebenezer borehole to 0.072±0.022 Bq/L in Galadimawa borehole, the mean value of alpha activity in borehole is 0.034±0.013 Bq/L, as shown in figure 3 pie chart and line graph in figure 4

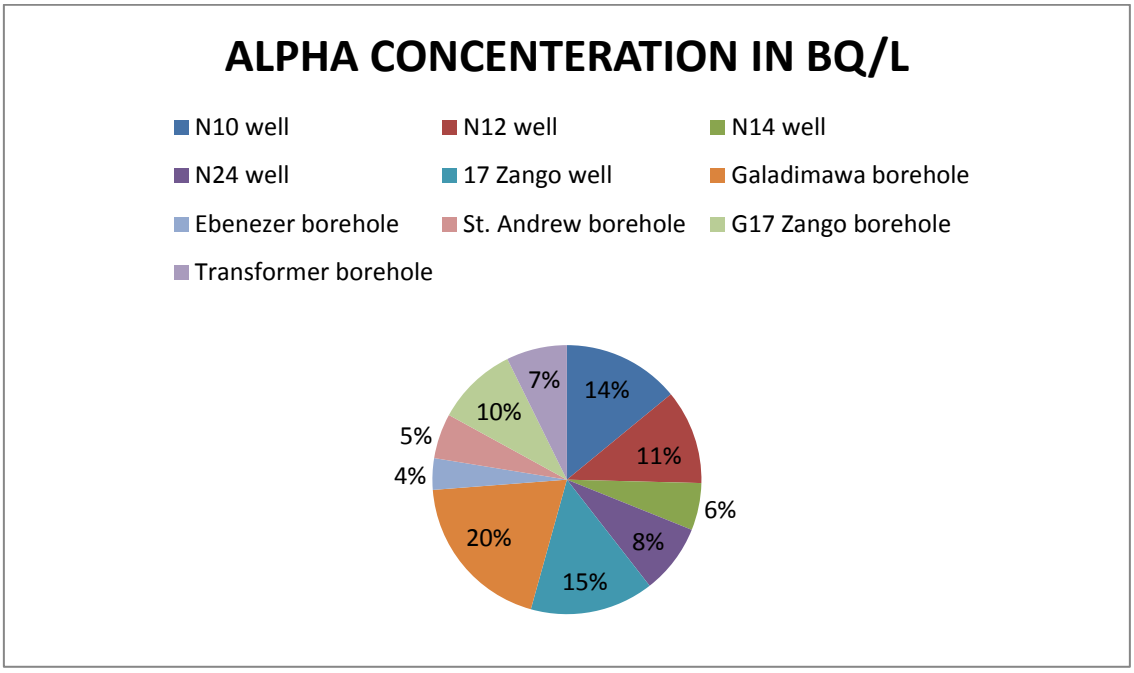

Figure 5: Pie chart showing alpha concentration in Bq/l in all the samples

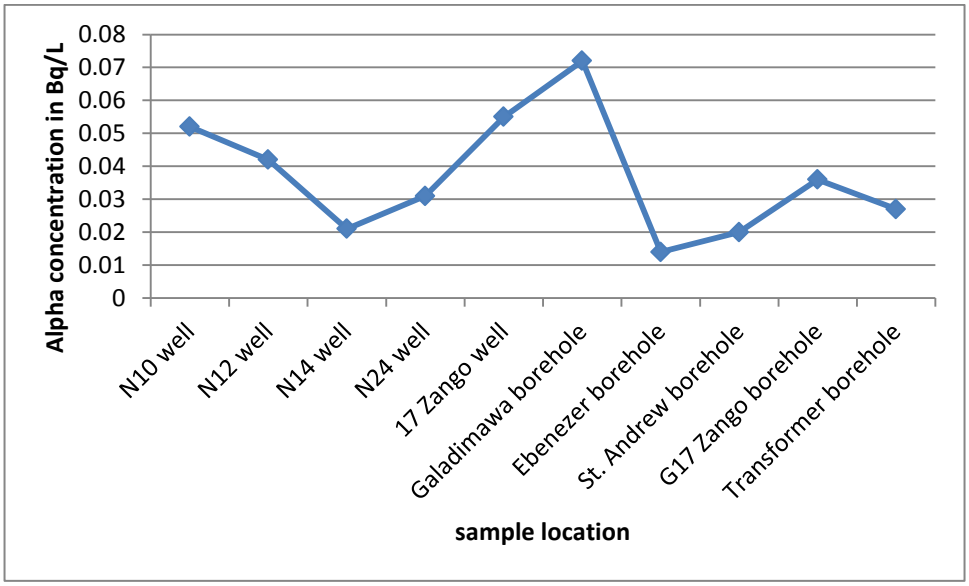

Fig 6: Line graph showing alpha concentration in Bq/l in all the samples

The concentration of alpha measured in hand dug wells and boreholes water samples are presented in table 1 the alpha activities ranged from 0.014±0.006 Bq/l to 0.072±0.022 Bq/l, with a mean value of alpha activity of 0.037±0.014 Bq/L, the distributions of the activities of the alpha concentration in both hand dug well and borehole are represented in pie charts figure 5 and line graphs in figure 6. The mean value of the activities of the alpha concentration for hand dug well is greater than the borehole in this study.

It can be seen that the alpha concentration meets the standard set by the WHO and ICRP despite that the Galadimawa borehole sample has the highest alpha concentration and Ebenezer borehole having the lowest as indicated by the pie chart and line graph still it does not exceed the minimum set standard i.e. 0.5 Bq/L per year. We can therefore deduce that the water sample from the boreholes and hand dug wells is drinkable because it did not pose any threat to the health of the people in the area. This shows that the deeper we dig the more concentration of radioactive materials encountered. Comparing the mean value 0.037Bq/L of alpha activity obtained in this work with (2) which is 0.68Bq/L obtained in Jos, (5) which is 0.0039Bq/L in Kano, and (9) which is 0.0063Bq/L obtained in Zaria we see that this is relatively higher compare to the mean value in this work.

4. Conclusion

The method of gross alpha spectrometry has been used to determine the radioactivity concentrations of hand dug well and borehole water samples commonly consumed in some area of Kakuri in Kaduna south Kaduna state. The analysis of these water samples showed that the alpha activity concentrations measured for all samples are below the recommended activity by the ICRP and WHO. Hence this particular water samples is safe for drinking and can be used for other things like washing, cooking etc. Therefore, before a well or borehole is dug the geophysicist and geologist can help in getting samples of the water and getting it analyzed for alpha concentration before it is finally dug, establishment of monitoring programs to ensure the water treatment, is carried out if required is necessary and the sampling and analysis for radionuclide should be carried out routinely enough to characterize the gross alpha annual exposure

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References

1. Brassard PG (1996). Wetland and Water Pollution.Boston College of Environment. Aff. Law Review; 23(4): 885-919.

2. Agbalagba EO, Avwiri GO, and Chadumoren YE (2013). Gross α and β Activity Concentration and Estimation of Adults and Infants Dose intake in Surface and Ground Water of Ten Oil Fields Environment in Western Niger Delta of Nigeria. J. Appl. Sci. Environ. Manage. June 2013 17(2): 267-277

3. Habila N (2008). Survey of Gross Alpha and Beta Radioactivity in Jos City, unpublished M.Sc. thesis, University of Jos, Nigeria

4. Kozinski DH (1995). Natural Radioactivity and Inorganic chemistry of Ground Water in the Kirkwood-Cohansey Aquifer System, Southern New Jersey. U.S Geological Survey Water Investigation Reports 92-41

5. Tajudeen HV (2006). Survey of Radioactivity in Wells and Bore holes from Gwammaja Area of Kano City. unpublished M.Sc. Thesis Ahmadu Bello University, Zaria.

6. Ajayi T, Torto R, Tchokossa N, and Akinlua A (2009). Natural Radioactivity and Trace Metals in Crude oils: Implication for Health. Environ Geochem Health. 31:61-69.

7. Ahmed SA, John MS, Ndikilar EC (2014). An Assessment of Gross Beta Radioactivity Concentration in Underground Water In Nassarawa Town Of Nassarawa State Nigeria International Journal of The Latest Research In Science And Technology 3(5): 71-74.

8. Cothern CR and Roberts PA (1990). Radon, Radium and Uranium in Drinking water, Lewis Publishers. P206-301

9. Onoja RA (2004). Survey of Gross Alpha and Beta Radioactivity in Well Water From Zaria Area, Nigeria unpublished M.Sc. Thesis, Ahmadu Bello University, Zaria.

10. ISO (1992). International Organization on Standardization. Water Quality Measurement of Gross Alpha Activity in Non Saline Water, Thick Source Method, ISO (9696-1992 revised). Geneva, Switzerland.

11. ASTM, (1995).Standard test method for alpha particle radioactivity of water, ASTM D1943-90 and D1890-90

12. WHO (2003). PH in Drinking Water; Background Document for Development of WHO, Guidelines for Drinking Quality Water. World Health Organisation, Geneva