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DETERMINATION OF RADIOACTIVITY CONCENTRATION IN HARVESTED WATER WITHIN EKPOMA EDO STATE.

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ABSTRACT

The concentration of natural gross radioactivity was measured in the Harvested water of Ekpoma region (Edo State), this was done using the MPC 2000 gas proportional counter. The result of this study indicated that a general absence of serious pollution in the drinking water used in this region. The result obtained from the radioactivity concentration of gross-α and gross-β was ranging from 0.0027±0.01 Bq/L to 0.369 ± 0.02 Bq/L and from 0.003±0.001 Bq/L to 0.735±0.03 Bq/L respectively. The gross beta values were found to fall within the WHO recommended MCL of 1.0 Bq/L while the gross alpha value did not exceed the MCL value of 0.5 Bq/L.

Keywords: Gross radioactivity, Gas proportional counter, Pollution, Drinking water

INTRODUCTION

Water is one of the most natural valuable resources widely distributed all over the world. Rainwater harvesting as an alternative source of water for domestic use is becoming popular as public water supply is not always available and consistent (Abdul *et al*, 2009). Rainwater harvesting is a simple and low-cost technique that involves the capturing and storing of rainwater from roof catchments or directly for domestic, agricultural and environmental purposes (Chukwuma *et al*, 2012).

Harvested rainwater may be the only source of water supply for many rural and remote households where no other water supply is available, water authorities around the world are keen to explore alternative water sources to meet ever-increasing demands for potable water (Gardner *et al*., 2011). The water crises tend to be viewed as a water quality problem. Water quality is increasingly recognized in many countries as a major factor in the water crisis. Poor water quality has been principally associated with public health concerns through the transmission of water-borne diseases that are still major problems in Africa and many other parts of the developing world (Ongley, 1999).

Atmospheric contamination of harvested rainwater by various contaminants that harbor in the air has been noted by various researchers (TCEQ, 2007; Shyamala *et al*., 2008; Thomas and Green, 1993). Atmospheric deposition is the transfer of atmospheric pollutant (dust, particulate matter containing heavy metals, polycyclic aromatic hydrocarbons, dioxins, furans, sulphates, nitrates, etc.) to terrestrial and aquatic ecosystems (Amodio *et al*., 2014).

Human activities have increased the concentration of heavy metals in the environment. For example, anthropogenic activities e.g. industry, agriculture increase the contents of heavy metals in different environmental matrices e.g. water, soil, vegetables, fish etc. Many of these pollutants may be present in urban environments at variable rates according to the intensity of road traffic and the proximity of industrial clusters (UNSCEAR 2008). Sources of contaminants deposited from the atmosphere by washout and dust fall may be road traffic, sea spray, industrial and rural activities, local dust and long-range transport from other areas (Fang and Zheng, 2014; Sanchez *et al*, 2015). Atmospheric deposition makes an important contribution to storm water contamination, typically supplying nitrogen and a smaller proportion of suspended solids, phosphorus, dissolved organic carbon and heavy metals (Sanchez *et al*, 2015). Sazakli *et al.* (2007) noted that the low fluoride concentration in rainwater may force consumers to take a fluoride supplement to prevent dental decay if rainwater serves as the primary potable water source.

Presently, in Ekpoma Edo State the provision of pipe-borne water has not been regular and as earlier stated, most homes depend on harvested rainwater. Hence, there is a need to assess the quality of harvested rainwater in the study area. This will help to detect at early stage environmental pollution in the study area.

MATERIAL AND METHODS

Study Area

The area of Study is Ekpoma metropolis under the Esan West Local Government of Edo State and some of its environs where most of its inhabitants depend on harvested water for their commercial and domestic consumption. Ekpoma is the headquarters of the Esan West Local Government Area. The town is home to the Ambrose Alli University. Ekpoma has its

geographical coordinates as 6°45′North, 6°80′East with 59,618 inhabitants and has an elevation of 333m above sea level.

Sample Collection

The samples were randomly collected in Ekpoma metropolis, Edo State at different locations which include: Ihumudumu, Ujoelen, Eguare, Ujemen, Emaudo, Uke, Idumebo, Ukpenu, Emuhi, Igor, Aburimen and G2 area. The samples were collected in a dry-cleaned 2 liters plastic sample bottles. The water samples from the reservoir were collected with the aid of a bailer. Water samples were collected manually from a community reservoir with varying depths. Also, samples of borehole water were collected in another community which is about 5-10km from the study area which served as a control. After collection, the samples were immediately acidified with 10ml of concentrated nitric acid per 2liter of the samples collected to minimize the adsorption of radioactivity into the walls of the containers (ISO 9697 & 9698: 1992). These weretaken to the center for Energy and Research Training Zaria for the analysis of gross alpha and beta concentration. The samples were analyzed without allowing them to stay longer, this was done to achieve maximum accuracy due to the fact that the composition of the sample may change if allowed to stay long before carrying out the analysis IAEA (1989).

Map of collection area is shown in Fig 1.

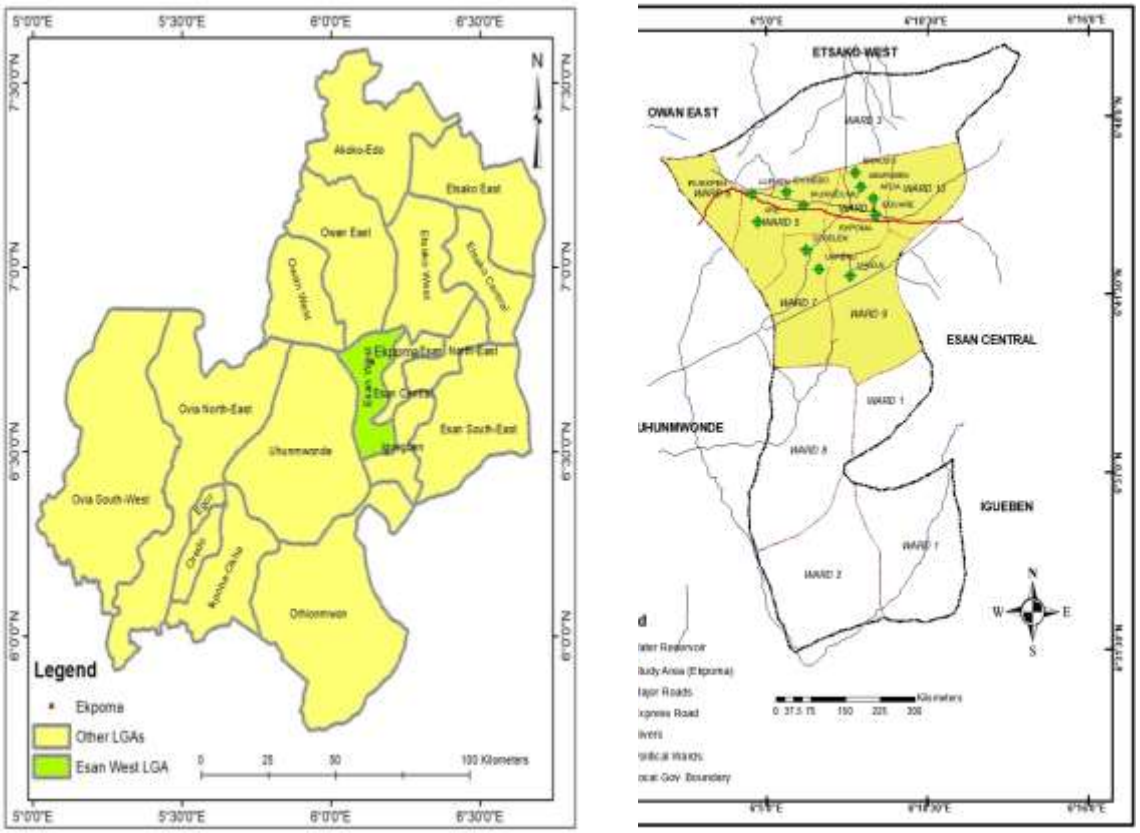

Fig 1. Map of the Study area.

Sample Preparation for Gross Alpha and Beta Radioactivity determination in water Procedure

500ml of the sample was measured into a beaker and then placed on a hotplate for evaporation, the hotplate was switched on and maintained a temperature of about 50 ^{0}Cto60 ^{0}Cso as to prevent boiling, the sample gradually reduces to 50ml which was then be transferred into an empty weighed petri-dish, which is placed on the hotplate for surface drying just to obtain residue, few drops of vinyl acetate was added which act as a binder and removal of the moisture content from the residue before the measurement (IAEA 1989). The weight of the empty planchette and that of the planchette plus residue was first measured as the mass of residue to be counted. Drops of ethanol were used to provide a uniform spread of residue on the planchette.The residue will be allowed to dry and will be covered with a Mylar film which was be stored for some days to attain a secular equilibrium and was ready for counting.

The gross activities of alpha and beta were estimated using a gas-flow detecting counting system (Model: MPC 2000 Gas flow Detector Dual phosphor), SERIALNO: Ø8172MØ protean instrument corporation at the center for Energy Research and Training Zaria

Sample analysis

These samples that have been prepared was analyzed using free gas proportional Counter located at the center for Energy Research and Training (CERT), Ahmadu Bello University, Zaria- Nigeria after they were allowed to stay for three hours after preparation and measurement was carried out within 24 hours after preparation.

Measurement of Gross Alpha and Gross Beta Activity

The operational modes used for the counting were the α-only mode for the alpha counting and the β mode for the beta counting. Each sample was counted for 45minutes at a high voltage of 1600V and 1700V respectively for the Gross Alpha and Gross Beta. For the Alpha counting, the gas-free proportional counter was set at alpha mode only and the result in count per minute will be displayed as the set time of 45minutes elapsed. The count rate and the activity was calculated using equation 1 (Ibeanu 1999):

$$\text{Activity A} = \frac{Netcount}{D.EXS.VXS.EX60} \quad (1)$$

For the Beta counting the gas-free proportional counter was set at Beta mode only and result in count per minute was displayed as the set time elapsed. The count rate and activity was calculated using equation 2 (Ibeanu 1999):

$$\text{Activity B} = \frac{NetCount}{D.EXS.VXS.EX60} \quad (2)$$

Where D.E is detector efficiency, S.E is the sample efficiency, S.V is sample volume

Net Count = Raw count – Background count.

Detector Calibration

Plateau test was run with the manufacturer's calibration standard whose activities range from 133.29-185.49Bq and 92.31-103.68Bq respectively in all the operating modes. The test was carried out for 2700sec for 5 cycles, with the operational efficiency of the channel of the counter was 87.95% for the alpha counts and 42.06% for the beta counts.

Background Count

The counting system was first used to count clean empty planchets for all the modes to obtain the background radioactivity of the environment which is necessary for other subsequent measurements of samples. The background radioactivity for Alpha was 0.53cpm for Beta 0.50cpm. This result was put into consideration for subsequent count obtained during the analysis of the sample.

Result analysis

The discussion of this study is based on the Gross alpha and Gross Beta analysis of Harvested water. All data are presented in table 1.

Gross alpha and Beta

Table 1 shows the result obtained from analysis carried out. It is seen that harvested water with the highest recorded activities for alpha are those of Emaudo (0.36916Bq/l), Eguare (0.39377 Bq/l) and Uhiele (0.34455 Bq/l). Others with relatively elevated activities are Afua (0.16489 Bq/l), Aburimen (0.14028 Bq/l) and Owen-Odia (0.12213 Bq/l). In General, there is actually a low alpha activity concentration in some of the water samples in the study area while some are a bit high but indicating that there is no radiological threats from alpha radiation in the study area that could be traced to the harvested water. For the Beta analysis, Afua HW 18, with 0.73591Bq/l has the highest reading, followed by Emaudo HW 13 with 0.72047Bq/l, Eguare HW 20 with 0.41170Bq/l, Aburimen HW 16 with 0.39111Bq/l, Eguare HW 19 with 0.37567 Bq/l, Uhiele HW 22 with 0.32421Bq/l with all analyzed HW are with the maximum acceptable limits of 1.0Bq/l. There is slight correlation between high beta values and relatively high alpha values for HW 13 in Emaudo community and also low alpha values and relatively low beta values for HW within 1 to 10Ujemen to Ujoelen. This may imply that different radionuclides may be responsible for low measurement of alpha activity.

Table 1Gross Alpha and Gross Beta activity concentration of Harvested water samples.

S/N	Geographical Coordinates	Location	Activity Concentration	
			Alpha (Bq/L)x10^{-3}	Beta (Bq/L)x10^{-3}
1.	6°40′18″N;6°05′09″E	HW 1 HW 2 } UJEMEN	0.00271 ± 0.01 0.00369 ± 0.01	0.00566 ± 0.01 0.03310 ± 0.01
2.	6°44′59″N;6°05′29″E	HW 3 HW4 } IDUMEBO	0.00911 ± 0.01 0.00743 ± 0.01	0.01904 ± 0.01 0.03049 ± 0.01
3.	6°38′48″N;6°05′57″E	HW 5 HW 6 } IHUMUDUMU	0.00723 ± 0.01 0.00376 ± 0.01	0.04028 ± 0.01 0.00787 ± 0.01
4.	6°38′11″N;6°06′23″E	HW 7 HW 8 } UKE	0.01100 ± 0.01 0.00905 ± 0.01	0.03179 ± 0.01 0.02696 ± 0.01
5.	6°44′20″N;6°07′03″E	HW 9 HW 10 } UJOELEN	0.00301 ± 0.01 0.00406 ± 0.01	0.00314 ± 0.01 0.00314 ± 0.01
6.	6°39′52″N;6°07′55″E	HW 11 HW 12 } UKPENU	0.04931 ± 0.01 0.07006 ± 0.01	0.16499 ± 0.02 0.19881 ± 0.02
7.	6°40′10″N;6°08′11″E	HW13 HW 14 } EMAUDO	0.36916 ± 0.02 0.11567 ± 0.02	0.72047 ± 0.03 0.10292 ± 0.02
8.	6°39′42″N;6°08′23″E	HW 15 HW16 } ABURIMEN	0.14028 ± 0.02 0.11567 ± 0.02	0.30877 ± 0.03 0.39111 ± 0.03
9.	6°39′45″N;6°08′39″E	HW17 HW 18 } AFUA	0.16489 ± 0.02 0.09844 ± 0.02	0.10292 ± 0.02 0.73591 ± 0.03
10.	6°39′50″N;6°09′04″E	HW 19 HW 20 } EGUARE	0.00984 ± 0.01 0.39377 ± 0.03	0.37567 ± 0.03 0.41170 ± 0.03
11.	6°45′60″N;6°09′12″E	HW 21 HW 22 } UHIELE	0.34455 ± 0.02 0.11567 ± 0.02	0.16983 ± 0.03 0.32421 ± 0.03
12	6°44′28″N;6°08′26″E	HW23 HW 24 } OWEN-ODIA	0.04833 ± 0.02 0.12213 ± 0.02	0.13955 ± 0.02 0.24388 ± 0.02

Variation of activity concentration.

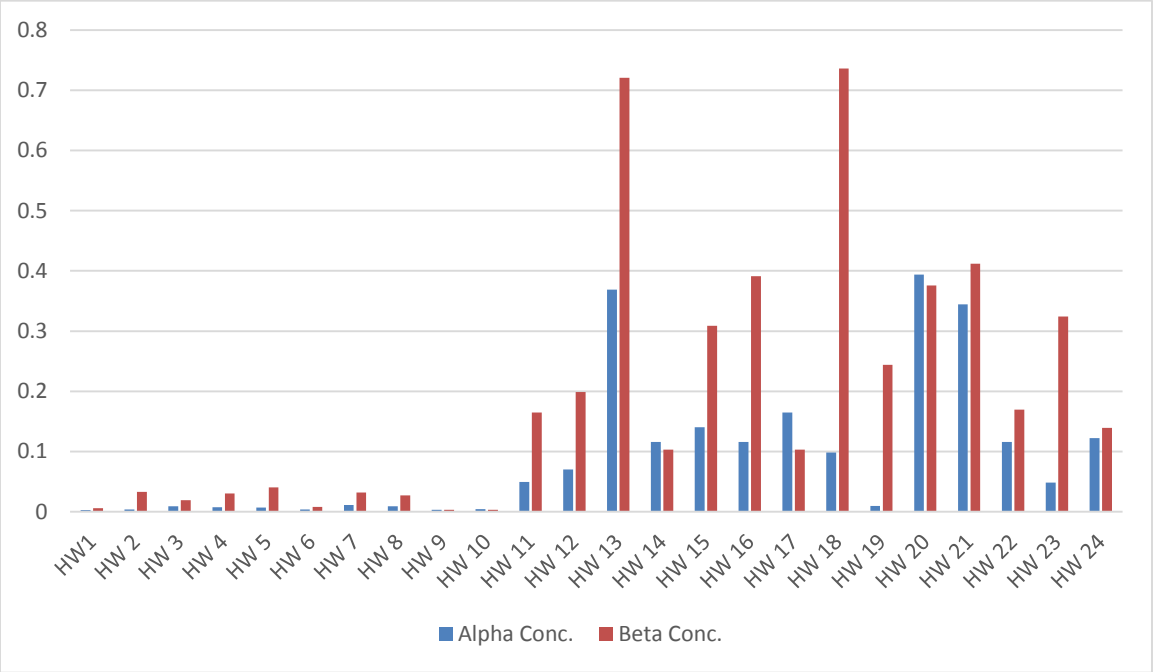

Fig. 3 Comparison of Alpha and Beta Activity across the sample points

CONCLUSION

This study is based on the radioactivity in Harvested water. Harvested rainwater were collected from different locations within Ekpoma Edo State, places which includes Ihumudumu, Ujoelen, Ukpenu, Eguare, Idumebo, Emuhi, Owe-Odia, Ujemen, Afua, Abhulimen, Uke and Uhiele community. A total of 24 samples were collected during this period from the sampling sites, taking utmost care in sampling and storage.

From the analysis carried out for the gross activity for alpha concentration, the highest recorded was 0.36916 Bq/L and for Beta concentration highest activity recorded was 0.7359 Bq/L. This indicate areas of alpha and beta activity concentrations, Based on the findings of this research work it is concluded that Harvested water within ekpoma a suitable for consumption and other domestic functions as the values obtained for beta and alpha activities are below limits when compared with ICRP (1991) maximum acceptable values of 0.5 Bq/L for alpha and 1 Bq/L for beta.

This result obtained showed that both alpha and beta concentration of the harvested water are within the recommended value by World Health organization (WHO) and not exceeded both the local and international standards.

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