ASSESSMENT OF RADIONUCLIDE CONCENTRATIONS IN SOME PUBLIC WATER IN USE IN MAKURDI METROPOLIS OF BENUE STATE, NIGERIA.

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ABSTRACT

This work assessed the concentration of radioactive elements found in some public water samples in use in Makurdi metropolis of Benue State, Nigeria. The study area is an agrarian community where agro-chemicals are normally used and there is a frequent health breakdown as a result of water sources in use. It was carried out in Makurdi between March September 2007. Geiger Muller Counter was used to measure the radiation concentrations in the water samples from hand dug wells, streams, boreholes, tapwater, bottled water and sachet water from five geographical locations of the metropolis (East, West, North, South and Central). Ten grab samples from each water source were collected and laboratory analyses were carried out in the Physics Department of Benue State University. It was observed that the highest radiation was in borehole ranging from 2.86 X 10^{-1} Bq (in the East) to 3.69 X 10^{-1} Bq (in the North). The least radiation was from bottled water 0.55 X 10^{-1} Bq (in the Central) to 0.77 X 10^{-1} Bq (in the South).

Key words: Radionucleids, public water, human health.

INTRODUCTION

Water is one of the most essential elements for human existence in any location. It is used for drinking, domestic and agricultural purposes etc. It can contain man-made and naturally occurring radioactive materials that dissolve from the soil it passes over or through (United States Dept of Health and Human Services, US, DHHS, 2004) and (Children's Health Environmental Coalition, CHEC, 2002). Rain and snow also wash man-made and naturally occurring radioactive materials out of the air. According to Agency for Toxic Substances and Disease Registry (ATSDR, 2004), radioactive materials may be added to water through planned or accidental releases of liquid radioactive material from hospitals, research institutes, manufacturing plants or nuclear reactors. Radionuclides can also penetrate surface waters when airborne radioactive materials settle on the earth or are brought down by rain or snow, and when soil containing them is limited by the size of the bodies of water into which they have drained. Eventually, radionuclides in runoff that goes into rivers and streams may reach the oceans. Examples of radionuclides that occur naturally in the soil are Uranium, Radium, Thorium, Potassium, and Tritium.

The Environmental Protection Agency (EPA) in every country is responsible for Federal Radiation Protection Guidance for Environmental Radiation Standards and Regulations to implement specific statutory requirements, such as the Safe Drinking Water Act and the Clean Air Act. The EPA sets

limits on the maximum acceptable concentration of radionuclides in public drinking water supplies. Based on the Safe Drinking Water Act, the EPA will issue Drinking Water Standards for radionuclides which include dose limits of 0.04msv / year (ATSDR, 2004). Some harmful effects associated with exposure to radionuclides include some genetic malformations, miscarriages, leukemia and damages to DNA, and cancers, among others (Henry, 2005; Hudson 2003 and Skipton et al, 2005). On considering uranium in public and private water supplies, Skipton et al, (2005) observed that Uranium accumulates in the bone similar to other radionuclides and have toxic effect on human kidney. Earlier investigation by US EPA (2000) on the effect of Uranium in underground water also revealed the presence of lead in water which causes neurological and reproductive damage to developing babies when it is assimilated through the placenta. According to US DHHS (2004) the presence of Strontium in well water can cause cancer and leukemia. In Nigeria, Idoko, (2002) investigated the concentration of radioactive isotope in water at Faringada, Jos and reported that the radiation level of well water in the area was about 1.5×10^{-1}Bq. In this work, investigations into the concentrations of radionuclides in public water supply such as bore-hole, hand dug wells, pipe borne water, streams, sachet and bottled waters were carried out in Makurdi metropolis of Benue state in order to identify the levels of radiation.

MATERIALS AND METHOD

Study Area

Benue State lies within the area bounded by latitude $6^0 30'$ and $8^0 15'$N and longitudes $6^0 30'$ and $9^0 40'$E. Makurdi the capital city of Benue State of Nigeria lies between latitudes $7^0 39'$ and $7^0 45'$ N and longitudes $8^0 33'$ and $8^0 35'$E. It is traversed by River Benue, one of the two major rivers in Nigeria. And yet, the availability of potable water supplies in the area is below expectation. Hence, the people in the area rely on such sources of water as borehole; hand dug well, streams, sachet and bottled water. Water from some of these sources pose a lot of problems to human and animal health because of some radioactive elements present in them. The underlying geology of the State could be put into four broad groups viz; Basement complex, Cretaceous sediments, Cretaceous intrusions and volcanic and the Alluvium (FDA, 1985). Makurdi the State Capital is underlain by Basement complex which consists mainly of gneisses, quartzite, magmatites and granites or complexes/ intergrades of these rock groups.

Data Collection

The data for this work was collected biweekly for six months (March September 2007) from five geographical locations (North, South, East, West, and Central) of the Makurdi town. In each of the geographical locations, water samples were collected from five handdug wells, two streams, ten taps, ten sachet water each from five different types produced in Makurdi, and five bottles each from five different types of bottled water on sale in the metropolis. The brand names of these sachet and bottled water are withheld for security reasons.

Laboratory Analysis

The Geiger Muller counter was used to measure the radiation from the water

samples. Geiger Muller is an instrument used to detect radioactive emission in samples such as water, sediments, dust, background radiation etc. This instrument generates a pulse of electrical current each time radiation passes through the tube and causes ionization. Each pulse is electrically detected and registers as a count which is displayed on the liquid crystal display (LCD). The inspector (sensor) of this instrument is optimized to detect small change in radiation levels and to have high sensitivity to common radionuclides.

Measurements were made every ten minutes by positioning the inspector at a distance of 2cm vertically above the sample in a beaker. Mean of ten counts (replications) was taken. The predetermined ambient or background count of 30.1cpm = 0.50cps was deducted from the mean count to get the actual level of radiation in the water samples by using equation 1.

$$R_a = R_m - R_b \quad (1)$$

where Ra = actual level of radiation, Bq; R_m = mean value of ten counts, Bq;

and R_b = ambient or background radiation, Bq.

Count or activity is the rate of disintegration (radiation) per second which is equal to Becquerel (Bq).

RESULTS AND DISCUSSION

Figure 1 shows the average distribution of the radionuclides contained in the various sources of water investigated as obtained in the five geographical locations of the town. In each geographical location the bar numbers 1, 2, 3, and 4 represent Well water, Stream water, Tap water and Borehole water respectively as shown in the legend. Also Table 1 summarizes the values with respect to geographical location. It could be observed that the hand dug wells has the least radiation in Makurdi Central while the highest was obtained in the West. In fact with respect to hand dug wells, the order of radiation is West > South > North > East > Central. The order of radiation with respect to stream water is of the form East > West > South > North > Central. The tap water is of the order South > East > Central > West > North. In boreholes the pattern of variation of the radionuclides is West > North > South > Central > East.

Further, it could be deduced from Figure 1 that the pattern of radiation from the water sources in the five geographical locations is of the form: Borehole > Hand dug well > Stream > Tap water. This implies that the groundwater sources (borehole and hand dug well) contain radioactive elements more than other sources. This could be attributed to the geologic formation of Makurdi which is basement complex or outcrops consisting mainly of gneises, quartzites, magmatites and granites may have rocks of high radioactive elements. This was also reported by Isikwue (2005). Drilling exposes rock surfaces thereby increasing the radioactive elements in the water (Weir, 2004; US EPA, 2005; and Henry, 2005). The higher radiation amount of radioactive materials in borehole than in well (though both are groundwater sources) could be attributed to variation of radiation with depth which confirms US EPA (2005).

It is to be noted that bottled water and sachet water were not included in figure 1 because those five different types investigated upon were not produced in Makurdi. But observation from Table 2 shows that the radionuclide concentrations in sachet water were more than those in bottled water. This could be as a result of purification processes.

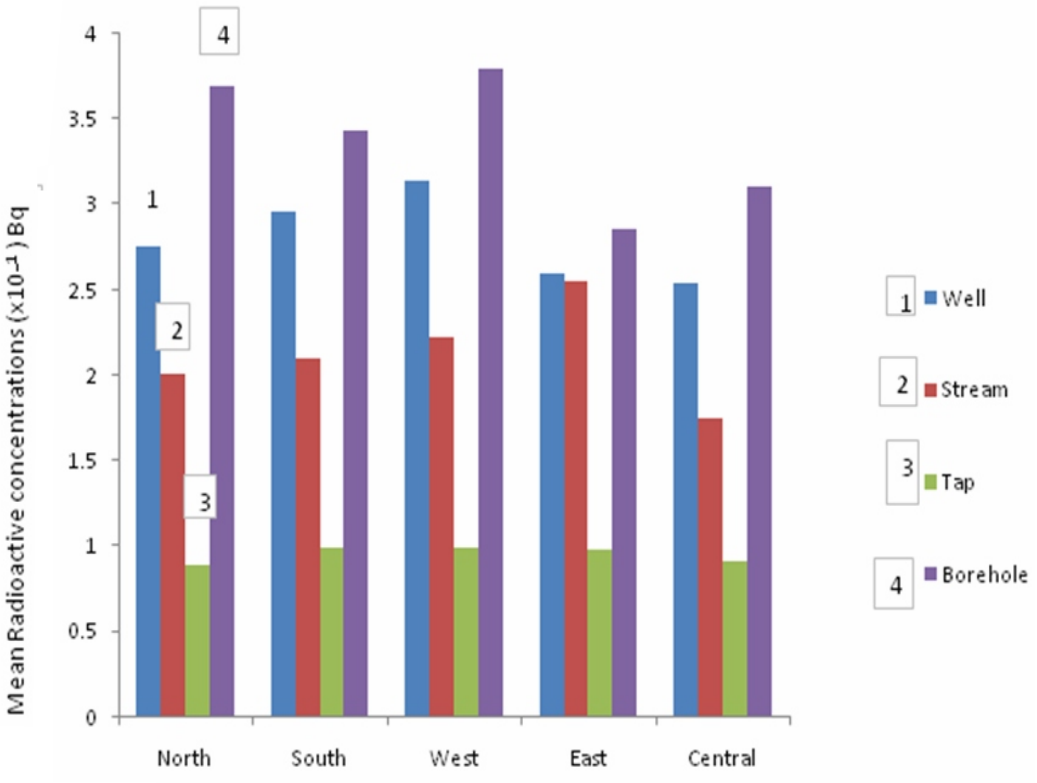

Figure 1: Average distribution of radionuclides in various sources of water according to geographical locations

Table 1: Mean values of the radioactive element concentrations in the water sources according to geographical locations.

Source of	Geographical location/Radionuclide concentrations (X 10^{-1})				
Water	**East**	**West**	**North**	**South**	**Central**
Hand-dug well	2.59	3.14	2.75	2.96	2.54
Stream	2.55	2.22	2.01	2.10	1.75
Tap water	0.97	0.90	0.88	0.99	0.91
Borehole	2.86	3.80	3.69	3.43	3.11
Sachet water	1.01	1.11	1.21	1.00	1.12
Bottled water	0.72	0.56	0.65	0.77	0.55

Table 2 shows the summary of the mean values radionuclides concentrations for the various sources of water in Makurdi town as a whole. These values were got using equation 1. It is obvious from Table 1 that water from borehole had the highest amount of radiation (3.38 X 10^{-1}Bq) while bottled water had the least (0.65X 10^{-1}Bq). The high quantity of radioactive elements in streams (though less than the groundwater sources) may be due to effluents mainly from hospitals, brewing plants (Benue Breweries and Coca-cola bottling Company) located in the Eastern part of the metropolis (Table 1). This confirms

why the pattern of radiation variation in stream water is East > West > South > North > Central (Figure 1). This variation followed the concentration of hospitals and production industries and plants within the metropolis.

The use of agrochemicals for agricultural purposes and presence of minerals in soils (US EPA, 2005) could be the possible explanation of the observed increase in the radionuclides in ground and surface waters (boreholes, wells and streams respectively) than in the tap, bottled and sachet waters (Figure 2).

Table 2: Mean values of radioactive element concentrations in the water sources monitored

S/N	Source of water sample	Radiation Concentrations	
		Disintegration per minute (cpm)	Disintegration per second ($X10^{-1}$)Bq
1	Well water	16.76	2.80
2	Stream water	12.79	2.13
3	Tap water	5.56	0.93
4	Borehole	20.26	3.38
5	Sachet water	6.53	1.09
6	Bottled water	3.90	0.65

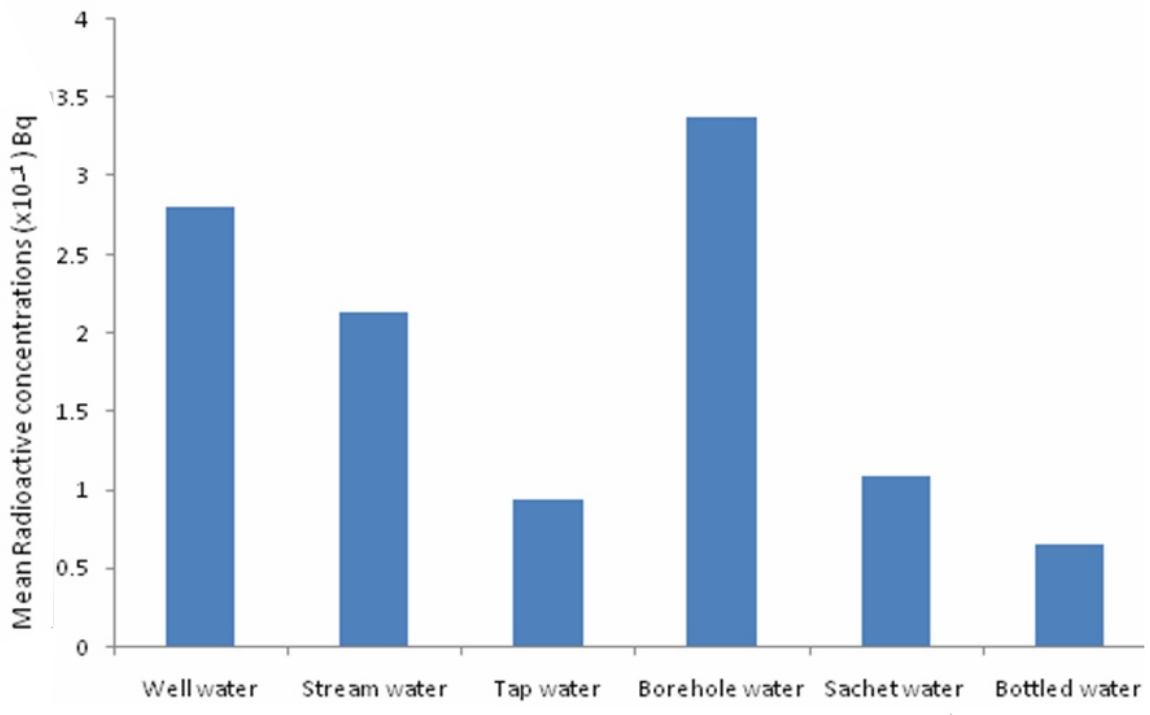

Figure 2: Average distribution of radionuclides in various sources of water

The highest amount of the radionuclides in the underground water (borehole and hand dug wells) could be attributed to the geologic formation of Makurdi being in the sedimentary basin and underlain by Makurdi sandstone, shale and alluvium deposits of varying depths and compositions. The higher amount of radioactive materials in boreholes than in wells could be due to variation of radiation with depth (US EPA, 2005). The observed increase in the radionuclides in ground and surface waters (boreholes, wells and stream) than in tap, bottled and sachet water could be due to the presence of some minerals and Agrochemicals present in the soil (US EPA, 2005).

It is plausible to mention that only the water from hand-dug well was significantly different from all other sources at both 5% (F-$LSD_{0.05}$ = 3.01) and 1% (F-$LSD_{0.01}$ = 4.77) levels of probability. This difference was only on the geographical location. The explanation of this may be due to the type of radionuclides which was not investigated in this work. All the wells were built up with burnt bricks (to avoid collapsing) which are a popular building material in the study area. And these burnt bricks are mainly got from the Eastern part. Probably they could be contributing a type of radionuclides different from other types in the other water sources.

CONCLUSION

The mean radiation exposure level for the various sources of public water in Makurdi metropolis was found to be within the range of $0.65X10^{-1}$ $3.38X10^{-1}$Bq. It is important to note that long time accumulation of the radionuclides in the body acquired from these water sources may be harmful to the consumers. It is therefore, hereby suggested that the populace of Makurdi metropolis should reduce the consumption of water from borehole, hand dug wells, and streams without adequate treatment. Hence the governments' effort to provide pipe-borne water for public consumption, especially in a situation where many people cannot afford the cost of bottled water considering the low economic standard of the people in the area. Also the drinking of sachet water (the so called pure water) which is more prevalent in Makurdi metropolis should be checked. Hence, NAFDAC (National Agency for Food Drug Administration and Control) should beef up efforts to ensure that productions of this sachet waters are well scrutinized from time to time. This will help to keep the producers in check. In addition, this study serves as a step to further investigate the types of radionuclides present in water in Benue state and Nigeria as a whole. Attempts to identify the types of the radionuclides present in the water will help the public to avoid those sources containing dreadful radionuclides. It will also help the comparison with the standard dose limit as given by World Health Organization (WHO).

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