

SURVEY OF LEVEL OF RADIOACTIVITY IN DRINKING WATER AT WUDIL AND ITS ENVIRONS

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ABSTRACT

Water samples were collected from ten (10) open wells and six (6) bore holes in Wudil town and its environs to analyze the level of radioactivity in such water samples. The samples after being acidified with nitric acid to preserve and reduce the pH value were evaporated using hot plate and the residue dried and transferred into weighted planchette. Proportional counter was then used to count for gross alpha (α) and gross beta (β). The results obtained indicated that the α and β activity in the water samples are on a much lower side compared to the minimum allowable level in drinking water as recommended by the International Commission on Radiological Protection (ICRP).

KEYWORDS: Radioactivity, DNA damage, Radiation Detection, Ionizing Radiation, α , β and P^H

INTRODUCTION

Portable or drinking water may be contaminated with radioactive substance that may make the water unfit for human consumption. Such substances may come from two sources namely naturally occurring and man-made sources. Man-made radioactivity is usually found in surface water while the naturally occurring radioactivity is from bedrocks [1].

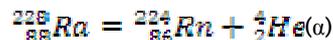
Effect of Radioactive Substance on Human Health

Radioactive substances usually emit ionizing radiation such as α , β and gamma (γ) radiation. These kinds of radiation when found in the human body deposit energy to water molecules in the body leading to formation of reactive radicals that eventually attack the cells in the body [2].

The radioactive substance may gain entry into the body through ingestion, inhalation, absorption or insertion. These ty The attack on the cells by the reactive radicals may lead to damage of deoxyribonucleic acid (DNA) in the cells of the body. If the damaged cell is not repaired or ill-repaired the effect of such damage may be transferred to daughter cells and this may subsequently result to cell death, uncontrolled cell division, tumor formation and/or cancer [4].

The most dangerous radioactive substance found in drinking water is radium (Ra) because it is an α

emitter as illustrated in equation 1.1 [5]. α is a strongly ionizing radiation because it has a very high Linear Energy Transfer (LET) such that it deposits an amount of energy to the magnitude of 180 keV within an infinitesimally small space of $1 \times 10^{-9}m$. This subsequently leads to rapid ionization within the targeted organ of the body, massive cell deaths and fast tumor formation leading to cancer [6]. The linear energy transfer for β radiation is however comparatively low such that it deposits less than one quarter of 1eV within the same space of $1 \times 10^{-9}m$. It therefore has much less ionizing effect in human body compared to the former (α). The emission of such deadly radiation (α) by radium takes place as:



Radioactive elements such as strontium-88 (${}^{88}_{38}Sr$) and radium-226 do mimic calcium-40 ($Ca-40$) and they are therefore deposited in the bone when ingested. Such elements are however deadly because they emit dangerous radiation as shown in equation 1.1, while $Ca-40$ is safe in that regard. Emission of such lethal radiation in the bone may lead to bone cancer [8].

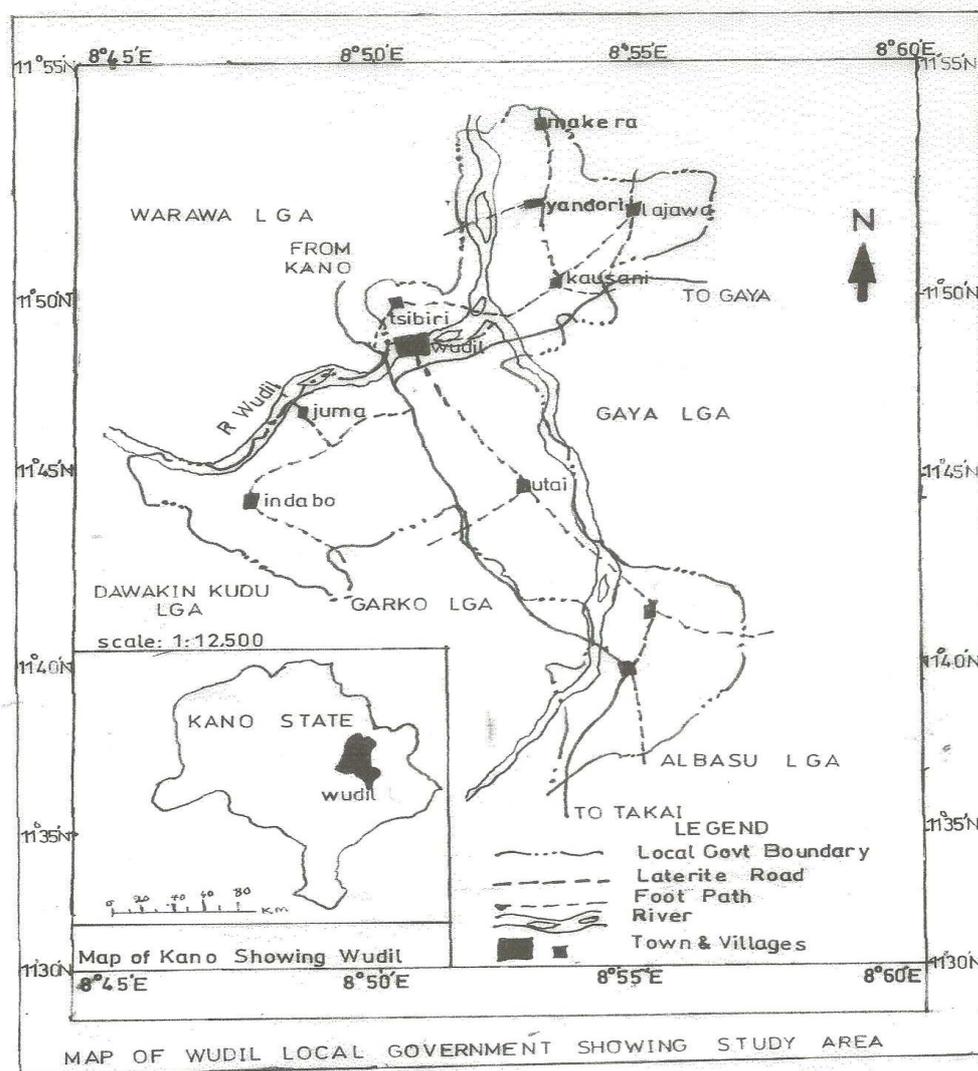


Figure 1.1: The Study Area

Methodology

The water samples (about two liters each) were collected randomly from 10 dug wells and 6 bore holes in Wudil and its environs. About 20 ml of concentrated nitric acid was added into each water sample to reduce the P^H and minimize precipitation. Hot plates were used to evaporate the samples without stirring and each sample took about 18 hours to evaporate all the water using a 1000 ml Pyrex glass beaker as the container. The residue was washed using distilled water and dried under infra-red lamp. The residues (identified by the names of the collection centers) were counted for gross α and gross β using a gas flow proportional counter.

RESULTS AND DISCUSSIONS

The α and β distribution in the samples are as shown in Table 1.1. The results show that the highest α activity is found in the water sample drawn from Makeera and this location is far away from River Wudil and the topographical condition in the areas is slightly mountainous and rocky. On the other hand, α activity in the water drawn from Wudil and Juma is below detection limit and these two locations are very close to the Wudil River. Thus this very low α activity in the water drawn at these two locations may have a direct bearing with the proximity to the river.

Table 1.1: Activities due to Alpha and Beta in the Water Samples

S/N	Geog. Coordinates	Location	Alpha (Bqm ⁻³)	Beta (Bqm ⁻³)
1	00851.133N,1146.112E	Juma WW	BDL	0.500 ± 0.02
2	00850.110N, 1148.364E	Juma BW	0.0099 ± 0.001	0.33 ± 0.01
3	00583.569N, 1148.885E	Kausani WW	0.031 ± 0.001	0.056 ± 0.002
4	00854.198N, 1149.653E	Kausani BW	0.0077 ± 0.001	0.063 ± 0.002
5	00854.673N, 1152.615E	Lajawa WW	0.017 ± 0.001	0.017 ± 0.001
6	00855.259N, 1151.815E	Lajawa BW	0.0011 ± 0.001	0.011 ± 0.001
7	00853.114N,1154.563E	Makera WW	0.195 ± 0.005	0.0328 ± 0.006
8	00853..116N, 1154.507E	Makera BW	0.016 ± 0.001	0.088 ± 0.002
9	00852.404N, 1148.445E	Tsibiri WW	0.012 ± 0.001	0.012 ± 0.001
10	00851.013N, 1143.061E	Tsibiri BW	0.059 ± 0.001	0.018 ± 0.001
11	00853.082N, 1145.041E	Utai WW	0.023 ± 0.006	0.0422 ± 0.001
12	00853.112N, 1145.364E	Utai BW	0.0025 ± 0.001	0.390 ± 0.01
13	00851.055N, 1148.36E	Wudil WW	0.0021 ± 0.001	0.640 ± 0.02
14	00851.055N, 1148.36E	Wudil BW	BDL	0.300 ± 0.01
15	00853.367N, 1152.949E	Yandoji WW	0.0089 ± 0.001	0.098 ± 0.002
16	00853.367N, 1152.949E	Yandoji BW	0.04 ± 0.001	0.1 ± 0.001

Key: WW = well water, BW = bore hole water and BDL = below detection limit

It is also observed from the results that generally, activity measured in well water is higher than that in bore hole water and this signals that the activity may be depth dependent. The two water sources (well and bore hole) are likely to be at different water tables, with the bore hole being a deeper source and does not have much contribution from surface radioactivity due to human interaction with the environment.

The gross α activities in the water drawn from wells and bore holes at Wudil and its environs are found to be in the range of 0.195 Bq/m³ to 0.012 Bqm⁻³. These levels of radioactivity are on a much lower side compared to the measured levels of radioactivity in water drawn from Kano and Zaria which have the values of 11.48 Bqm⁻³ to 2.06 Bqm⁻³ and 43.19 Bqm⁻³ to 0.58 Bqm⁻³ respectively. The gross β activity shows similar trend such that the maximum β activity measured in water drawn from wudil and environs is only 0.640 Bqm⁻³ while the maximum values of β activity measured

at Kano and Zaria are 4.32 Bqm⁻³ and 6.35 Bqm⁻³, respectively.

Comparing the results obtained with data from global locations as per Table 1.2 shows that on the scale of radioactivity in drinking water, the water drawn from Wudil and environs is much safer than the water drawn from other global locations such as Netherlands, United Kingdom and Venezuela. In fact the level of radioactivity determined in the water at Wudil and environs is a minute fraction of the threshold level in drinking water as per the 1976 recommendation by the United Nation Scientific Committee on Effects of atomic Radiation (UNSCEAR) and World Health Organization (WHO). The detail of such recommendation is as follows:

- Maximum α activity in water is 550 Bqm⁻³
- Maximum activity due to radium-226 and radium-228 is 185 Bqm⁻³
- Maximum β activity is 1850 Bqm⁻³

Table 1.2: α and β Radioactivity of Water from Wudil and Other Locations

S/N	Location	α Act (Bqm ⁻³)	β Act (Bqm ⁻³)	Source
1	Wudil	0.195	0.640	This Work
2	Kano	11.48	4.32	Habibat (2006)
3	Zaria	43.19	6.35	Onojah (2004)
4	United Kingdom	150		CEC (1992)
5	Belgium	27.8	13.60	CEC (1992)
6	Netherlands	64.0	5.0	Brills (1985)
7	Venezuela	540.0	23.0	ANSI (1989)

CONCLUSION

Based on the results obtained, it is concluded that the levels of α and β radioactivity in the drinking water drawn from Wudil and environs are exceptionally low such that the levels are below detection in water samples drawn from two centers (Wudil and Juma). The level of radioactivity in the water drawn from the areas under study seems to have direct bearing with proximity of the collection centers to Wudil River.

The drinking water drawn from Wudil and environs is safer because the level of α radioactivity measured in the water samples from Wudil (0.195 Bqm⁻³) is over 2000 times less than the allowable level of radioactivity in water because the International Commission on Radiological Protection (ICRP) and the World Health Organization WHO recommended in 1976 that the maximum allowable α radioactivity in drinking water is 550 Bqm⁻³.

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