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Assessment of radiation level in yam and cassava in two council wards in Kwande Local Government Area of Benue State

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RESEARCH ARTICLE

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Abstract: The study was undertaken to assess the level of radiation on yam and cassava in two selected council wards in Kwande Local Government Area of Benue State-Nigeria. A total of twenty (20) samples for both yam and cassava were selected from each settlement in the two selected council ward in the local government area. The samples were examined for radiation level using a Radiation Alert meter. The radiation level ranges from 0.039 to 0.018μSv/hr for yam samples. The annual dose estimated for yam intake in the two selected council wards were above the recommended limit of 1.00 μSv/hr by USNRC in some sample locations (AD1, AD5, AG3 AG4, and AG5) and below, in other locations (AD2, AD3, AD4, AG1, and AG2) whereas, radiation and dose level on cassava at the sample locations ranges from 0.017 to 0.199 μSv/hr. The annual dose estimated for cassava intake was below the recommended limit of 1.00 (mSv/hr) USNRC in all the sample locations except in AD1 which was above the recommended limit.

Keywords: *radiation, effective, State-Nigeria*

1. INTRODUCTION

Radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium. This includes electromagnetic radiation, such as radio waves, microwaves, infrared, visible light, ultraviolet, x-rays, and gamma radiation. Human has always been exposed on a daily basis to natural radionuclides such as Thorium (^{232}Th), Radium (^{226} Ra), and Potassium (^{40}K) [1]. These radionuclides found in crops such as yam and cassava, contribute to the radiation human are exposed to, because these crops an important part of a human diet, a source of nutrients and they constitute important functional food components with protein, vitamins, iron, calcium and other nutrients to the body [2]. There is an inherent tendency of these crops (yam and cassava) to take up toxic substances and some radionuclides which are unstable nuclei with a high ratio of proton to neutron [3]. Natural activities like a volcanic eruption and anthropogenic activities expose originally concealed radioactive elements in the rocks within the earth's crust. Agricultural practices such as excessive use of fertilizers add radioactive elements in the soil, transport agents like run-off water and rivers, and spreads these radionuclides within the soil. The radionuclides disintegrate to form lighter atoms by emitting radiations like alpha, beta, and gamma rays. Exposure of human beings to ionizing radiation when humans consume crops such as yam and cassava is a continuous and inevitable occurrence on the earth, but can minimized, because these crops emit radiation by disintegration of natural radionuclide and contribute to the total absorbed dose via ingestion, inhalation and external irradiation [4]. There is also a *background* of natural radiation everywhere (ubiquitous) in our environment. Ubiquitous background radiation comes from space (that is, cosmic rays) and from naturally occurring radioactive materials contained in the earth and in living things, crops absorb cosmic radiation from the sun and this cosmic radiation comes from extremely energetic particles from the sun and stars that enter Earth's atmosphere [3]. Some particles make it to the ground, while others interact with the atmosphere to create different types of radiation, the radiation levels increase as you get closer to the source, so the amount of cosmic radiation generally increases with elevation [5].

2. MATERIALS AND METHOD

The materials used for this research are Radiation Alert meter, Meter rule and Stop watch. The radiation Alert meter was used to measure the radiation level of the yam and cassava at different farm locations within the two council wards. The background radiation measured with the same meter as four different locations (north, south, east and west) within the selected cassava and yam farms to get the average values for background radiation. The meter was placed 30cm from the source of the yam and cassava samples and the meter was switched on after which values were taken severally (three times per sample) and recorded for 30 seconds each, an average readings were calculated. The difference between the radiation on the samples and the background radiation gives

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the radiation on the yam and cassava in the study area.

2.1 Conversion of the measured radiation from CPS to µSv/hr

The values obtained for the assessment of radiation in count per second (CPS) were converted to Sv/hr using:

$$\mathrm{Z\ \mu Sv/hr} = \mathrm{Z\ CPS\ X\ 0.0057} \quad \text{.................................}1$$

Where Z is the value of the measured radiation in CPS on the sample and 0.0057 is the calibration factor for the radiation alert meter used [6]

2.2 Estimation of dose level in mSv/hr

Since radiation rate measurements were made in µSv/hr by the survey meter, the dose level (D) was obtained by making proper unit conversions. For Ḋ measured in µSv/h, to obtain D in mSv/yr conversion was made as shown in equation 2 below

$$\boldsymbol{D}\left(\frac{mSv}{y}\right) = \frac{D\left(\frac{\mu Sv}{h}\right)\frac{(24hrs)}{d}\frac{(365d)}{y}}{10^{3}\left(\frac{\mu Sv)}{mSv}\right.} \quad \text{.............}2$$

The annual dose calculated using equation 1 was finally compared with the limit of 1 mSv/y recommended for the public [7].

2.3. Annual effective dose due to the ingestion of food crop

The effective dose is a useful concept in the radioactivity measurement that enables for the summation of all radiations absorbed by different organs. The annual effective dose due to the ingestion of food contaminated with radiation was obtained from equation 3 below;

$$\mathbf{HT,r} = \sum(\mathbf{U^i\ X\ C^i_r})\ \mathbf{X\ g_{Tr}} \quad \text{...................}3$$

Where i is the food group, U^i is the food consumption rate (kg/yr), C^i_r is the radiation concentration (Bq/kg^{-1}), and $g_{T,r}$ is the dose coefficient (5.9×10^{-9} $SvBq^{-1}$).

The U^i statistics used for the different crops in Nigeria was obtained from the Food Agricultural Organization (FAO). The U^i used for the different crops in Nigeria were 118.86 and 30.64 kg/person/yr for yam and cassava respectively [8]

RESULT AND DISCUSSION

The table below shows the measured values of radiation and the annual effective dose level on yam at the study locations.

SAMPLE ID	SAMPLE LOCATION	CPS	µSv/hr	Dose(mSv/hr)	USNRC(mSv/hr)
AD1	Mbaiwen	32.00	0.182	1.589	1.000
AD2	Haanya	18.60	0.106	0.928	1.000
AD3	Rice mill	7.000	0.039	0.341	1.000
AD4	ACC	10.00	0.057	0.499	1.000
AD5	Kajo	23.60	0.134	1.173	1.000
AG1	Gbe	15.40	0.087	0.762	1.000
AG2	Nambe	15.50	0.076	0.665	1.000
AG3	Agir	27.00	0.153	1.340	1.000
AG4	Koti	28.00	0.163	1.247	1.000
AG5	GRA	27.00	0.153	1.340	1.000

Table 1: Radiation level on yam samples

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The table below shows the measured values of radiation and dose level on cassava at the study locations.

SAMPLE ID	SAMPLE LOCATION	CPS	µSv/hr	Dose(mSv/hr)	USNRC(mSv/hr)
AD1	Mbaiwen	21.00	0.199	1.743	1.000
AD2	Haanya	18.60	0.106	0.928	1.000
AD3	Rice mill	1.700	0.009	0.078	1.000
AD4	ACC	10.00	0.057	0.499	1.000
AD5	Kajo	3.200	0.018	0.157	1.000
AG1	Gbe	3.100	0.017	0.148	1.000
AG2	Nambe	5.100	0.029	0.254	1.000
AG3	Agir	18.50	0.105	0.919	1.000
AG4	Koti	3.500	0.019	0.166	1.000
AG5	GRA	3.500	0.019	0.166	1.000

Table 2: Radiation level on Cassava samples

The table below shows the annual effective dose calculated for yam intake at the study locations.

SAMPLE ID	SAMPLE LOCATION	CPS	µSv/hr	AED(mSv/hr)	WHO(mSv/hr)
AD1	Mbaiwen	21.0000	0.1990	0.0320	0.1
AD2	Haanya	18.6000	0.1060	0.0016	0.1
AD3	Rice mill	01.7000	0.0090	0.0014	0.1
AD4	ACC	10.0000	0.0570	0.0090	0.1
AD5	Kajo	03.2000	0.0180	0.0028	0.1
AG1	Gbe	03.1000	0.0170	0.0026	0.1
AG2	Nambe	05.1000	0.0290	0.0045	0.1
AG3	Agir	18.5000	0.1050	0.0016	0.1
AG4	Koti	03.5000	0.0190	0.0030	0.1
AG5	GRA	03.5000	0.0190	0.0300	0.1

Table3: Annual effective dose (AED) for yam intake

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The table below shows the annual effective dose calculated for cassava intake at the study locations

SAMPLE ID	SAMPLE LOCATION	CPS	µSv/hr	AED(mSv/hr)	WHO(mSv/hr)
AD1	Mbaiwen	32.0000	0.1820	0.0110	0.1
AD2	Haanya	18.6000	0.1060	0.0065	0.1
AD3	Rice mill	07.0000	0.0390	0.0027	0.1
AD4	ACC	10.0000	0.0570	0.0039	0.1
AD5	Kajo	23.6000	0.1340	0.0093	0.1
AG1	Gbe	15.4000	0.0870	0.0061	0.1
AG2	Nambe	15.5000	0.0760	0.0053	0.1
AG3	Agir	27.0000	0.1530	0.0100	0.1
AG4	Koti	28.0000	0.1630	0.0100	0.1
AG5	GRA	27.0000	0.1530	0.0100	0.1

Table 4: Annual effective dose (AED) for cassava intake

The results shown in the tables above are given in a bar chart representation in Figure 1 to 4 below.

The chart shows the radiation and heavy metal concentration level of all the samples for yam and cassava at different sample locations.

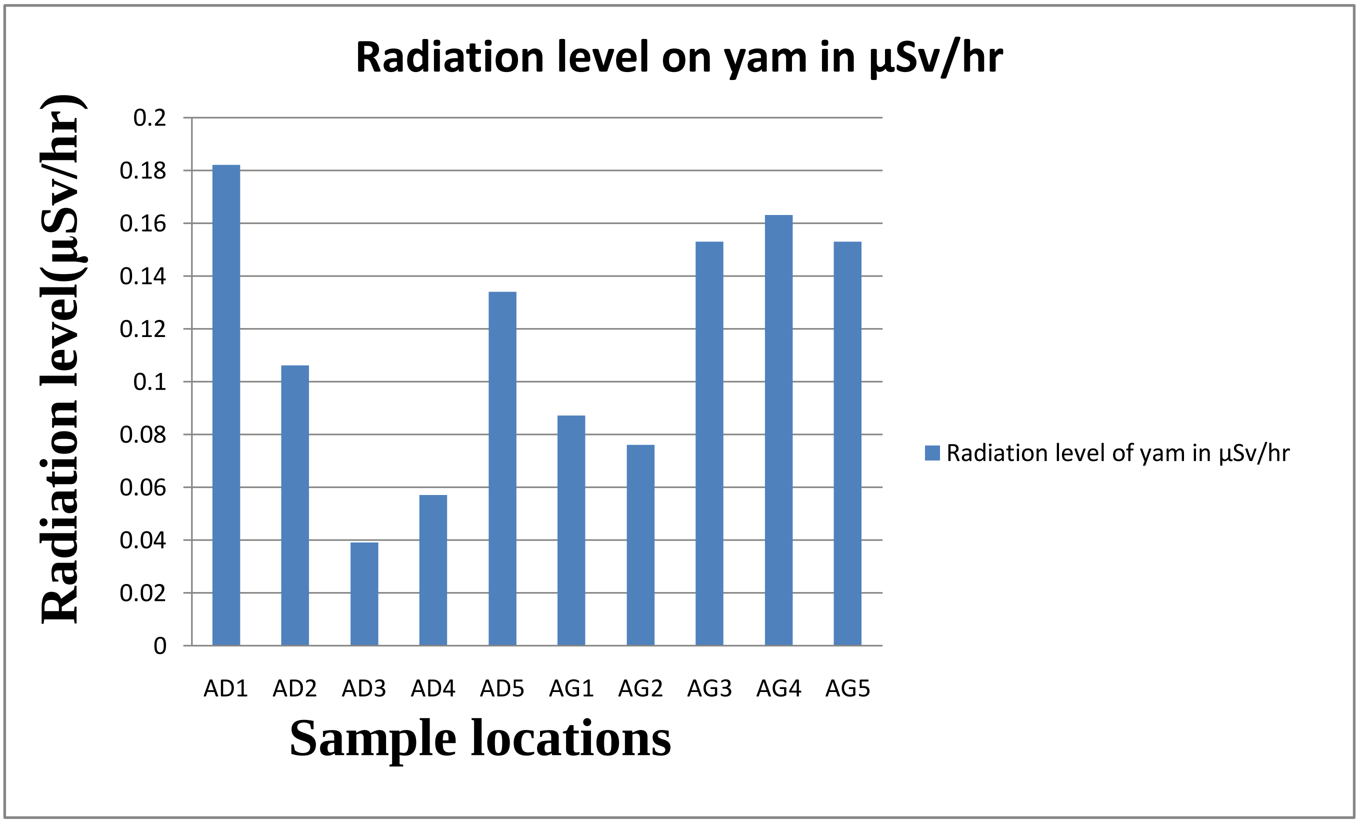

Figure 1: Radiation level on yam

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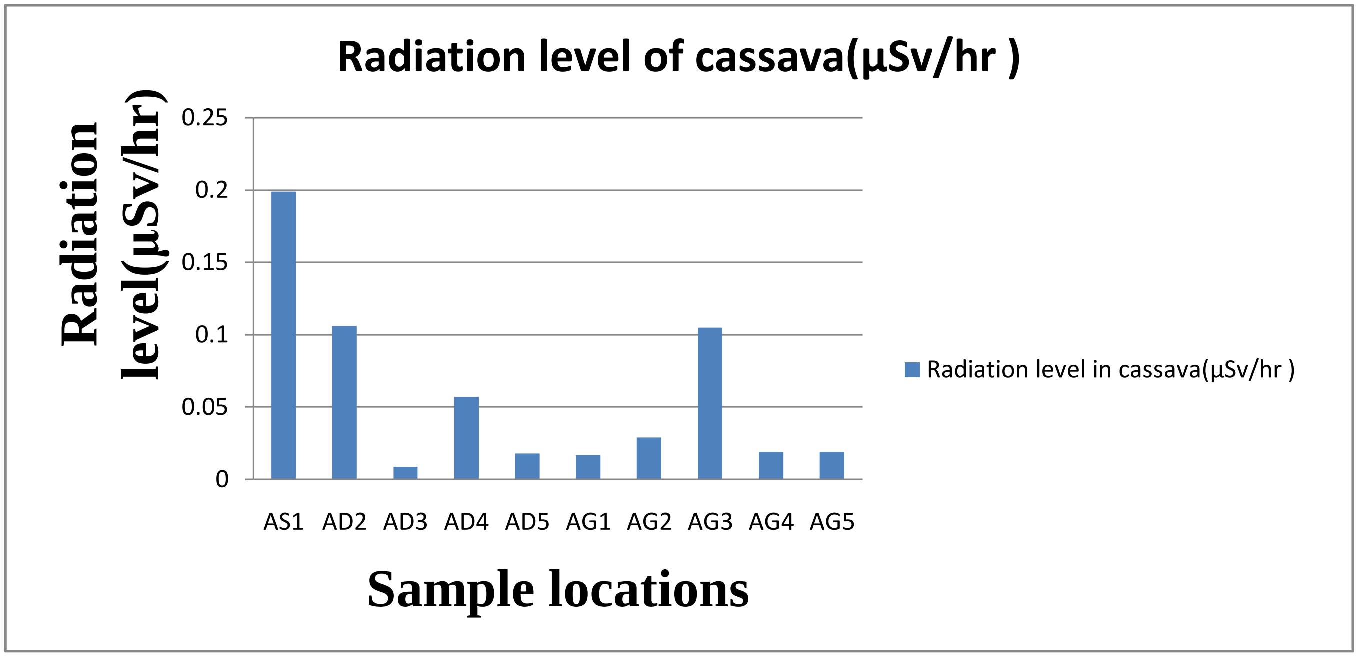

Figure 2: Radiation level in Cassava

DISCUSSION

Following the results as presented in table 1 to 4 and figure 1 to 4 for the findings;

Table 1 showed the measured radiation and the dose level in yam at the sample locations. The radiation level ranges from 0.039 to 0.018 µSv/hr, dose level in AD1, AD5, AG3, AG4 and AG5 were above the recommended limit of the United State Environmental Protection Agency (USEPA) 1.0 mSv/hr whereas, the dose level in AD2, AD3, AD4, AG1, and AG2 were below the recommended limit of USEPA [9].

In a similar way, table 2 showed the measured dose level calculated for cassava intake which was below the recommended limit of USEPA (1.0 mSv/hr) except that of AD1 which was above the recommended limit.

High level of radiation in yam and cassava in some sample locations could be attributed to excessive use of fertilizers, pesticides, bio solids and manures. It could also be as a result of the high background radiation level in the sample locations. The high background radiation could be caused by the presence of mineral deposits within the sample locations. Studies revealed background radiation occurs naturally from mineral resources and a small fraction comes also from manmade elements. Naturally occurring radioactive minerals in the study areas could be responsible [10].

The annual equivalent dose was also estimated for both yam and cassava using equation 2, as shown in Table 5 above, the values obtained for the annual effective dose due to the ingestion of yam and cassava was 0.12 and 0.05 mSv/yr^{-1}. Comparing these with WHO recommended limit, the annual effective dose for yam was greater than the WHO recommended limit of 0.1 mSv/yr-1 whereas, the annual effective dose calculated for cassava intake was below the WHO recommended limit of 0.1 mSv/yr^{-1} [11]

Comparing the radiation level in yam and cassava from the values obtained, it was observed that, the radiation levels in cassava were low compare to that of yam, the reason could be that inhabitants may have considered yam to have needed more inorganic manure than cassava therefore, the value placed on yam and the application of fertilizer and other manure on yam farm could be said to be higher than that of the cassava. This also supports the fact that several soil types in Benue support cassava growth and production with little or no application of organic or inorganic manure. Generally, despites the availability of cassava and its other processing options, people still prefer yam to it. Subsequently, farmers are ready to invest more, and support its growth for greater production which in turn could have radiation effects on the crop. Balanced and effective use of inorganic manure is the way out considering the predominant use of these same crops in this part of the world.

CONCLUSION

In view of the national and international standards set by well-meaning organizations such as WHO, USNRC, USEPA, NSFQ, and sister organizations, radiation level on yam is higher, while that of cassava is lower, sequel to this, the consumption of cassava and its processable products can be said to be safe. At the other hand, further investigation and monitoring of yam in those locations is highly recommended for food safety and security. Considering the contribution

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of Benue people especially in this local area of the State in food supply locally and even internationally, it's crucial to be assured of food standards and for greater production while farmers themselves are in good health.

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