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Radiological Assessment of Some Foodstuffs from Major Markets at Sagamu in Ogun State Southwest of Nigeria

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Abstract

Activity concentrations of ^{40}K, ^{238}Uand ^{232}Th in some foodstuffs from major markets at Sagamu, Ogun State Southwest of Nigeria had been determined by gamma spectrometry method using NaI (TI) detector coupled with a pre-amplifier base to a multiple channel analyzer (MCA). Fifteen (15) samples of maize flour, yam flour, beans, garri and rice were purchased from the markets: Sabo, Falawo and Awolowo. The highest concentrations of ^{40}K and ^{238}U were from maize flour of values 250.35 ± 13.47Bqkg^{-1} and 31.24 ± 3.51Bqkg^{-1} respectively. The highest concentration of ^{232}Th was found in beans with value 7.86 ± 1.02Bqkg^{-1}. The average annual committed effective dose of all the natural radionuclides to the consumers was calculated to be 0.159mSvyr^{-1} and the value obtained was below the worldwide average limit value which indicates that consumption of the foodstuffs has no negative radiological health risk to the consumers.

Keywords: Radionuclide; Activity concentration; Foodstuff; Dose; Gamma spectrometry.

1. Introduction

Radionuclides are generally found in different parts of the world. They are found in the soil, air and water naturally. They can be artificially made by activities of man. According to [1] assessment of our environment radiologically is so important to ascertain safety of man from radionuclides.

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Ingestion and inhalation are the main pathways through which natural radionuclides enter the human body. According to [2], ingested radionuclides could be concentrated in certain parts of the body. For example, Chemical uranium toxicity primarily affects the kidney, causing damage to the proximal tubule, while this metal has also been identified as a potential reproductive toxicant [3], ^{232}Th causes effect in lungs, liver and skeleton tissues and ^{40}K in muscles. Depositions of large quantities of these radionuclides in particular organs will affect the health condition of the human such as weakening the immune system, induce various types of diseases, and finally increase in mortality rate [2]. There are several sources contributing to plant contamination which can result in direct deposition of radioactive particles from the atmosphere onto the above-ground parts, indirect absorption of radionuclides from the soil by the root system, as well as the resuspension and deposition of radionuclides in the soil. The research work done by [4] concerning foodstuffs and water ingestion by human beings in India from uranium mining area of the study area revealed that the ingestion dose was below the dose limit of 1mSvyr^{-1} for public exposure in planned exposure situation as recommended by [5] indicating that the people are radiologically safe. Also, the study of natural radionuclides concentration levels was carried out by [6] along with their dose rates in some species of prawn. The average dose rate of all the radionuclides in the prawns was calculated to be 2.81 x 10^{-3} mGyhr^{-1} which was below the limit of 0.4 mGyhr^{-1} recommended by [7] as reported by [8] and therefore do not pose radiological health problem to the aquatic animals. This research work is to determine the radioactivity concentrations and annual committed effective dose of ^{40}K, ^{238}U and ^{232}Th from some foodstuffs purchased from major markets at Sagamu in Ogun State, Southwest of Nigeria to consumers.

2. Materials and methods

The method of gamma spectrometry was adopted for the analysis of the samples collected to obtain data on ^{40}K, ^{238}U and ^{232}Th. Fifteen (15) samples of foodstuffs from three major markets: Sabo, Falawo and Awolowo in the study area were purchased. They were oven dried at 80^{0}C [9], grinded, weighed, packed 145g by mass in plastic containers and carefully sealed and kept for twenty-eight days (28) to establish secular radioactive equilibrium between the natural radionuclides and their respective progenies. The method of gamma spectrometry was adopted for the analysis of the samples collected to obtain data on ^{40}K, ^{238}U and ^{232}Th. The spectrometer used was a Canberra lead shielded 7.6cm x7.6cm NaI (Tl) detector coupled to a multichannel analyzer (MCA) through a preamplifier base. The resolution of the detector is about 10% at 0.662MeV of ^{137}Cs. According to [10] the value is good enough for NaI detector to distinguish the gamma ray energies of most radionuclides in samples. For the analyses of ^{40}K, ^{238}U and ^{232}Th, the photo peak regions of ^{40}K (1.46 MeV), ^{214}Bi (1.76 MeV) and ^{208}TI (2.615 MeV) were respectively used. The cylindrical plastic containers holding the samples were put to sit on the high geometry 7.6cm x 7.6cm NaI (TI) detector. High level shielding against the environmental background radiation was achieved by counting in a Canberra 10cm thick lead castle. The counting of each sample was done for 10hrs because of suspected low activities of the radionuclides in the samples. The areas under the photo-peaks of ^{40}K, ^{238}U and ^{232}Th were computed using the Multichannel Analyzer system.

2.1 Theoretical consideration and calculations

The concentrations of the radionuclides were calculated based on the measured efficiency of the detector and the net count rate under each photopeak over a period of 10 hours using equation 1.0

$$C = \frac{N(E_\gamma)}{\varepsilon(E_\gamma) I_\gamma M t_c} \qquad 1.0$$

Where:

$N(E_\gamma)$ = Net peak area of the radionuclide of interest, $\varepsilon(E_\gamma)$ = Efficiency of the detector for the γ- energy of interest, I_γ = Intensity per decay for the γ- energy of interest, M = Mass of the sample, t_c = Total counting time in seconds (36000s). In addition, the annual committed effective dose (ACED) for ingestion of NORMs in foodstuffs is calculated using the expression [11] :

$$ACED = C \times DCF \times CR \qquad 2.0$$

Where:

C = Concentration of each radionuclide, DCF = Dose conversion factor for ingestion obtained from [12] and CR = Consumption rate of intake of NORMs from the foodstuffs

3. Results and discussion

The concentrations of the natural radionuclides in the foodstuffs from Sagamu are shown in table 1., the highest for ^{40}K, ^{238}U and ^{232}Th are 250.35 ± 13.4Bqkg^{-1} from maize flour, 31.24 ± 3.51Bqkg^{-1} from maize flour and 7.86 ± 1.02Bqkg$^{-1.}$ from beans, respectively. The mean concentrations of ^{40}K for all the samples was obtained to be 205.46 ± 11.12 Bqkg^{-1}, 23.00 ± 4.59 Bqkg^{-1} for ^{238}U and 5.19 ± 1.90 Bqkg^{-1} for ^{232}Th.

Table 1: Radioactivity concentrations of natural radionuclides in foodstuffs samples

SAMPLE LOCATION	FOODSTUFF	RADIOACTIVITY CONCENTRATION (Bqkg^{-1})		
		^{40}K	^{238}U	^{232}Th
Sabo	Yam flour	184.35 ± 9.32	26.34± 4.18	5.37 ± 2.18
Sabo	Maize flour	250.35 ± 13.40	29.14 ± 3.64	4.82 ± 1.96
Sabo	Beans	227.61 ± 11.61	18.37 ± 5.64	7.86 ± 1.02
Sabo	Garri	206.14 ± 10.78	24.06 ± 6.28	3.65 ± 1.84
Sabo	Rice	165.02 ± 7.36	17.12 ± 4.38	6.54 ± 3.37
Falawo	Yam flour	196.24 ± 8.61	22.16 ± 3.84	6.04 ± 2.69
Falawo	Maize flour	235.71 ± 11.46	23.84 ± 4.11	2.98 ± 1.34
Falawo	Beans	204.35 ± 13.65	17.26 ± 6.22	4.26 ± 1.25
Falawo	Garri	182.26 ± 10.28	27.14 ± 3.66	5.58 ± 2.02
Falawo	Rice	210.08 ± 12.49	30.24 ± 6.57	6.18 ± 1.83
Awolowo	Yam flour	204.46 ± 11.02	21.18 ± 5.26	6.15 ± 1.42
Awolowo	Maize flour	225.08 ± 15.63	31.24 ± 3.51	5.84 ± 2.07
Awolowo	Beans	199.65 ± 8.34	18.75 ± 4.36	3.96 ± 1.42
Awolowo	Garri	176.29 ± 9.85	14.34 ± 2.48	2.28 ± 1.03
Awolowo	Rice	214.32 ± 13.05	23.87 ± 4.72	6.39 ± 3.02
	RANGE	**165.02 – 250.35**	**17.12 – 31.24**	**2.28 – 7.86**
	MEAN	**205.46 ± 11.12**	**23.00 ± 4.59**	**5.19 ± 1.90**

No artificial radionuclide was detected in all the samples. The highest ACED to the consumers for ^{40}K was obtained to be 0.223mSvyr^{-1} with mean value of 0.184mSvyr^{-1} as shown in table 2. Also, highest ACED to the consumer for ^{238}U was obtained to be 0.202mSvyr^{-1} with mean value of 0.120mSvyr^{-1} and the highest for ^{232}Th was 0.260 mSvyr^{-1} with mean value of 0.172mSvyr^{-1}. The average for all the radionuclides was calculated to be 0.159mSvyr^{-1}. All the values obtained are below the world average recommended limit of 0.3mSvyr^{-1} [12] for ingestion of natural radionuclides.

Table 2: Calculated annual committed effective doses to consumers

SAMPLE LOCATION	FOODSTUFF	^{40}K ACED (mSvyr^{-1})	^{238}U ACED(mSvyr^{-1})	^{232}Th ACED (mSvyr^{-1})
Sabo	Yam flour	0.165	0.176	0.178
Sabo	Maize flour	0.223	0.189	0.160
Sabo	Beans	0.203	0.119	0.260
Sabo	Garri	0.184	0.156	0.121
Sabo	Rice	0.148	0.111	0.217
Falawo	Yam flour	0.176	0.144	0.200
Falawo	Maize flour	0.210	0.155	0.099
Falawo	Beans	0.182	0.112	0.141
Falawo	Garri	0.162	0.176	0.185
Falawo	Rice	0.188	0.196	0.205
Awolowo	Yam flour	0.182	0.137	0.204
Awolowo	Maize flour	0.201	0.202	0.193
Awolowo	Beans	0.179	0.122	0.131
Awolowo	Garri	0.158	0.093	0.076
Awolowo	Rice	0.192	0.155	0.212
	MEAN	**0.184**	**0.120**	**0.172**

4. Conclusion

The concentrations and annual committed effective doses of natural radionuclides in some foodstuffs from major markets at Sagamu in Ogun State of Nigeria had been determined, the values were within the limits recommended for safety globally indicating that the consumption of the foodstuffs by the people in the study area does not pose any radiological health risk to them.

5. Recommendations

- There should be peaceful co- existence amongst the tribes in Nigeria to avoid the use of nuclear weapons during clashes and pollution of the air, water and soil which can be transferred to plants and animals.

- There should be periodic assessment of our environment radiologically to ascertain safety of lives.

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