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Assessment of radionuclides content in imported foodstuffs in Kano state of Nigeria

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Abstract:
Assessing the levels of radionuclide's concentration present in human foodstuffs is very important for determining and estimating the radiation hazard to human health due to consumption. Though very few studies regarding to the level of radionuclide in foodstuffs have been conducted in Nigeria. The radionuclides concentration(^{40}K ^{137}Cs, ^{226}Ra and ^{232}Th) of twenty three imported foodstuffs sample were determined. Seven different varieties of foodstuffs were selected for analysis, the sample after pretreatment (if necessary), were measure using a low level gamma ray spectrometer. The radionuclides concentrations were present for all the study samples with ^{40}K ^{137}Cs, ^{226}Ra and ^{232}Th found to be in the range of (19.7 – 817, 0.006 – 3.10, 0.06 – 107.2, 0.013 – 109.8) Bq.kg-1 fresh weight(fw) respectively for the twenty three samples. The concentration of the radionuclides were compared with different studies from other researches, The concentrations of ^{40}K and ^{137}Cs in the imported sample of rice sample were higher than reported literatures, while less than reported for wheat, milk powder, tea and baby food respectively, or comparable with those from other literatures except for radionuclides concentration in rice which is higher.

***Keyword**: Radionuclide, samples, concentration, imported foodstuff, gamma ray spectrometer*

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I. Introduction

Natural radionuclide's exist in every human environment; soil, water, air, food, and even our own bodies contain naturally occurring radioactive materials. Usually, the natural radionuclides are very low activity concentrations. The primordial radionuclides ^{238}U and ^{232}Th exist in soil, in varying concentrations. These can be attributed to the nature of the parent rock during soil genesis. Studying transfer of natural radionuclides, like ^{238}U and ^{232}Th along with their daughter products through the biosphere is important because their ubiquitous presence and persistence in the environment (Murtadha Sh. Aswood et al). Human organs are known to exhibit varying degrees of radio sensitivity to radio nuclides. Following ingestion or inhalation the metabolism of radio nuclides in the body and the organs will alter its uptake into that organ and that, combined with the different radio sensitivities, with Radioactivity levels of staple foodstuffs and dose estimates for most of population. These produce different doses to different organs from the same contaminated food source. For instance, ^{137}Cs is very important because it follows the course of potassium in ecosystems and it persists in the environment for many years due to its relatively long half-life, 30.2 years. Furthermore, it is characterized as a potential genetic hazard because it accumulates in many types of human tissues and its penetrating gamma-rays reach all body cells (N A Mlwilo *et al 2007).* A radioactive element in food or water is absorbed in bodies of plants and animals by different mechanisms that are typically dependent on its chemical properties rather than its radioactive characteristics. For example, a plant in need of calcium and potassium will take them through its capillary roots from soil and will not discriminate against the radioactive ^{45}Ca and ^{40}K isotopes. Again the distribution patterns of uranium, thorium and their decay products are affected by certain chemical and biochemical interactions. The amount of these primordial radionuclides in food elements will accordingly depend upon the parent rock and the soil formation along with the transport processes that are involved(E. Kam et al, G.2016).Food is the primary wellspring of radioactive components and in this way of the inward radiation measurement. Radionuclides consumed by means of foodstuff represent a huge segment of the average radiation dosage to different body organs and are likewise a standout amongst the most imperative courses for long term wellbeing contemplations(Hany El-Gamal et al 2019).

This study will asses and determine the level of radioactivity in some imported foodstuffs that are commonly consumed by people living in kano state of Nigeria. For this purpose, the concentrations of naturally occurring radio nuclides in twenty three imported food samples will be carried out. The results will be compared with those from other literatures.

II. Materials And Methods

Materials

A twenty three Imported foodstuffs sample (Rice, wheat, Milk Powder, Tea, Baby food, Spices, frozen fish) of seven kinds of imported foodstuffs considered for the study from Kano state markets. Twenty three Marinelli Beaker for the samples and a Gamma ray Spectrometer.

Experimental Procedures

Imported foodstuffs samples was collected from the market in Kano state. The collection take place between April and May of 2022. To ensure a comprehensive and a wide-spread representation, 23 different brands of the imported foodstuffs samples that are sold in Kano state was bought from the market. Prior to gamma ray measurement, the sample were made to dry and were homogenized, and due to indirect measurement of ^{226}Ra and ^{232}Th each sample was made to become a powdered and placed in a Marinelli beaker. After being sealed, the sample-filled containers was left for a period of at least 5 weeks to reach secular equilibrium between parent Radio nuclides and their daughters. The measurements was performed Using Gamma ray spectrometer detector In which the gamma lines indicate the presence of radio nuclides in the measured sample. The Gamma- ray spectrum analysis of the selected samples for natural radioactivity was carried out by gamma spectrometer. The activity concentration of ^{226}Ra, ^{232}Th, ^{137}Cs and ^{40}K were calculated by the relation $A = \frac{\sum N - \sum B.G}{\varepsilon.\text{I.t.m}}$. This system can distinguish radionuclide gamma-ray energies. The sample types and their origins are listed Table 1 below.

The 300g of each samples that were packed in a marinelli beaker, and sealed for five weeks to reach the radioactivity equilibrium between parents and their daughter radionuclides, were measured by a gamma spectrometry system, manufactured by Canberra, using a High Purity Germanium (HPGe) detector with 40% relative efficiency. The detector was shielded by 10cm lead on all sides, with cadmium-copper in the inner sides. The measurement time for each sample was 172,000s. Spectrum analysis was performed by the spectran-software. The selected characteristic gamma peaks for the detection of different radionuclides were 509 keV for ^{226}Ra (^{214}Bi), 483 keV for ^{232}Th (^{208}Tl), 561 keV for ^{137}Cs and 1360 keV for ^{40}K. Efficiency calibration of the gamma spectroscopy system was performed by a marinelli standard mixed source. The minimum detectable activity (MDA) was approximately 12.2, 22.9, 11.7 and 182 mBq.kg-1(fresh weight, fw) for ^{226}Ra, ^{232}Th, ^{137}Cs and ^{40}K respectively.

III. Results And Discussions

The measured activity concentrations of ^{40}K, ^{137}Cs, ^{226}Ra and ^{232}Th in 23 different imported foodstuffs, including their uncertainty, are summarized in Table 1 below.

Table 1. Concentration of radionuclides in different inported foodstuffs in Nigeria (Bq.kg-1 fresh weight) (± Uncertainty).

No	Sample	Country	^{226}Ra	^{232}Th	^{137}Cs	^{40}K
1	Rice 1	Thailand	51.4±4.1	62.5±3.6	<0.1±0.02	166±9.6
2	Rice 2	Thailand	56.1±3.8	57.8±2.8	<0.09±0.01	137±5.9
3	Rice 1	India	104.3±8.6	106.1±7.3	0.029±0.008	156.1±8.7
4	Rice 2	India	107.2±7.8	109.8±8.7	0.050±0.016	158.1±9.8
5	Wheat	USA	0.47±0.037	<0.025	<0.010	136.3±6.3
6	Wheat	Russia	0.67±0.054	<0.039	<0.017	147.3±8.3
7	Wheat	Canada	0.26±0.039	<0.017	<0.014	113.3±4.5
8	Wheat	Australia	0.57±0.057	<0.043	<0.13	98.3±2.5
9	Milk Powder	India	0.069±0.017	0.143±0.031	2.30±0.01	630.0±19.8
10	Milk Powder	USA	0.154±0.010	0.124±0.027	3.10±0.092	480.0±14.1
11	Milk Powder	Turkey	0.060±0.034	0.116±0.019	1.86±0.066	570.6±17.3
12	Milk Powder	Netherland	0.17±0.056	0.094±0.047	1.18±0.023	520.3±12.8
13	Tea	Kenya	2.67±0.26	5.31±0.16	2.01±0.076	817±26.5

14	Tea	India	2.12±0.17	3.71±0.46	1.67±0.065	542±19.7
15	Tea	China	1.87±0.14	2.77±0.63	1.21±0.036	511±17.9
16	Tea	Srilanka	2.30±0.21	4.31±0.48	2.01±0.176	736±23.6
17	Baby food	Brazil	0.123±0.018	<0.018	<0.011	40.4±0.5
18	Baby food	China	0.105±0.013	<0.013	<0.008	54.8±0.9
19	Baby food	India	0.112±0.019	<0.015	<0.006	51.1±0.7
20	Frozen fish	Russia	0.587±0.103	0.159±0.074	0.071±0.017	62.7±4.1
21	Frozen fish	Netherland	0.431±0.093	0.137±0.041	0.065±0.012	57.4±3.9
22	Spices	India	1.01±0.13	0.25±0.079	0.044±0.008	27.4±1.4
23	Spices	China	1.07±0.43	0.37±0.061	0.087±0.016	19.7±1.02

^{40}K, ^{137}Cs, ^{226}Ra and ^{232}Th contents were measurable in all of the samples. The highest concentrations of ^{40}K, ^{226}Ra and ^{232}Th were found in tea sample to be equal to 817, 107.2 and 109.8 Bq.kg-1(fw), respectively. Also the lowest concentration of ^{40}K was found 19.7 Bq.kg-1(fw) in the spices sample. The lowest concentration of ^{226}Ra and ^{232}Th were found 0.06 and 0.013 Bq.kg-1 in milk powder and baby food samples, respectively. The highest ^{137}Cs concentration was obtained in milk powder to be equal to 3.1 Bq.kg-1 (fw). The minimum detected concentration of ^{137}Cs was found 0.006 Bq.kg-1 in baby food sample. The comparison in the concentration of radio nuclides content reported from different articles together with the current study is stated in Table 2 below.

Table 2. Concentration of radionuclide in different imported foodstuffs in Nigeria and other countries (Bq.kg-1 fresh weight).

No	Sample	Country	^{226}Ra	^{232}Th	^{137}Cs	^{40}K
1	Rice	Nigeria	51.4 - 107	57 - 109	0.09 - 0.10	137 - 166
		Brazil	<0.11	--	<0.04	14.7
		Hong Kong	0.006	--	0.02	15
		Taiwan	0.08	--	--	--
2	Wheat	Nigeria	0.026 - 0.67	0.017 - 0.039	0.010 - 0.017	98 - 147
		Russia	0.67±0.054	<0.039	<0.017	147.3±8.3
		Canada	0.26±0.039	<0.017	<0.014	113.3±4.5
		Australia	0.57±0.057	<0.043	<0.13	98.3±2.5
3	Milk Powder	Nigeria	0.06 - 1.7	0.09 - 0.14	1.18 - 3.1	480 - 630
		Venezuela	--	--	1.55	401.7
		Turkey	--	0.116±0.019	1.86±0.066	570.6±17.3
		Netherland	0.17±0.056	0.094±0.047	1.18±0.023	520.3±12.8
4	Tea	Nigeria	1.87 - 2.67	2.77 - 5.31	1.21 - 2.01	511 - 817
		England	0.005 - 15	--	--	--
		China	1.87±0.14	2.77±0.63	1.21±0.036	511±17.9
		Srilanka	2.30±0.21	4.31±0.48	2.01±0.176	736±23.6
5	Baby food	Nigeria	0.11 - 0.112	0.013 0.018	0.006 - 0.011	40 - 62
		European Communities	--	--	400	--
		India	0.112±0.019	<0.015	<0.006	51.1±0.7
6	Frozen fish	Russia	0.587±0.103	0.159±0.074	0.071±0.017	62.7±4.1
		Netherland	0.431±0.093	0.137±0.041	0.065±0.012	57.4±3.9
7	Spices	India	1.01±0.13	0.25±0.079	0.044±0.008	27.4±1.4
		China	1.07±0.43	0.37±0.061	0.087±0.016	19.7±1.02

In order to compare our results with the Results reported from other literatures, the activity concentrations of the same foodstuff in different countries from different studies are presented in Table 2. The ^{40}K ^{137}Cs, ^{226}Ra and ^{232}Th contents were measurable in most of the samples. The concentrations of ^{40}K and ^{137}Cs in the mentioned imported rice sample were higher than reported literatures, while less than reported for wheat, milk powder, tea and baby food respectively. or comparable with those from other literatures except for radio nuclides concentration in rice which is higher. Also, the obtained results in this study is higher than some reference values in UNSCEAR. The radionuclides concentrations in the sample foodstuff are in comparable with the reported values in different articles as well as the reference value. In addition, from the results of man-made radionuclides concentration in imported foodstuff we can conclude that this result we can say the study sample are within the permissible limit of radionuclides concentration.

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