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NATURAL RADIONUCLIDES CONTENT OF SOME LOCAL CEREALS IN AKURE, SOUTH WESTERN NIGERIA

A. M. AROGUNJO
Department of physics, Federal University of Technology Akure. Ondo State, Nigeria.

Abstract. The natural radionuclides contents of cowpea (*Vigna unguiculata* L walp), guinea corn (*Sorghum bicolor* L), rice (*Oryza sativa* L) and soyabean (*Glycin max* L) have been investigated. The specific activities ranged from 36.4 ± 13.5 Bqkg^{-1} to 186.9 ± 23.1 Bqkg^{-1} for ^{40}K, 0.2 ± 0.1 Bqkg^{-1} to 1.4 ± 0.5 Bqkg^{-1} for ^{238}U, and 0.3 ± 0.1 Bqkg^{-1} to 1.8 ± 0.7 Bqkg^{-1} for ^{232}Th. Cesium - 137 was not detected in any of the cereals investigated.

1. INTRODUCTION

There are many activities of man that can lead to the production of radionuclides in the environment [1]. These include releases such as ^{137}Cs and ^{90}Sr from nuclear power plants, medical and industrial applications of radioisotopes. Radionuclides resulting from these activities can find their way into the food chain thereby constituting great radiological impact on man, plants and animals. The soil, used mainly for agricultural purposes contains some amount of primordial radionuclides in varying concentrations. Constant application of potassium based fertilizer to the soil for high yield in crops has been confirmed to contribute to the average abundance of natural radionuclides [2]. The distribution and availability of radioactive substances inhaled and ingested could be attributed to geological processes, atmospheric conditions and human activities [3]. These natural and artificial radionuclides could be deposited on the leaf foliage of plants and on the soil anchoring these plants. These radionuclides will eventually get to the human diet through the direct absorption by plant (leaf) and through root uptake. The need to constantly assess all potential sources of radiation (internal and external) has being the major concern of many authors [4,5,6,7]. The most widely eaten foods by many Nigerian families are the cereals. It has therefore become imperative to assess the dietary intake of radionuclides due to their consumption. This can only be possible when the radiological data for the food samples are known. The dietary intake of radio cesium through food intake, especially mushrooms, has been investigated [8,9]. To assess radiation dose due to the ingestion of food and the determination of possible contamination of the soil with fission products like ^{137}Cs from atmospheric weapon test, it is necessary to have radiation data for reference, epidemiological, radiobiological and radiological assessment purposes.

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1. MATERIALS AND METHOD

The four cereals, which were cultivated in Akure, were purchased from local farmers and were air-dried, ground to powder to provide the same geometry with the mixed gamma sample from the International Atomic Energy Agency, Vienna, Austria (IAEA) used for the activity determination. About 100 – 200 g of the cereal samples were weighed and sealed in labeled plastic containers and kept for four weeks so that secular equilibrium will be reached between ^{220}Ra and ^{232}Th and ^{222}Ra and ^{238}U before counting [10]. The radionuclides content of the samples were determined using gamma ray spectrometer with energy resolution of 49 keV at 0.666 MeV from ^{137}Cs line at full width at half maximum (FWHM) with a relative efficiency of 8%. The spectrometer was based on a 7.6 cm x 7.6 cm NaI(TL) crystal as the detector connected to a Canberra series 10 plus Multichannel Analyzer. The spectra show ^{238}U and ^{232}Th with many photopeaks corresponding to different energies (609 keV, 1238 keV, 1764 keV, 2109 keV and 2204 keV for ^{238}U; 510 keV, 969 keV and 2614 kev for ^{232}Th due to the different gamma emitting progeny of these elements. The gamma ray peaks used for ^{137}Cs, ^{40}K, ^{238}U and ^{232}Th were 0.662 MeV, 1.46 MeV, 1.7 MeV due to ^{214}Bi and 2.65 MeV due to ^{208}Tl, respectively. The ^{214}Bi and ^{208}Tl line used for the activity determination of ^{238}U and ^{232}Th, respectively was based on the assumption that they are in secular equilibrium. The detector and the samples were shielded with a lead castle to minimize background radiation within the lead castle volume. The gamma counting of each sample was done for 12 hours because of the expected low activity of the radionuclides in the cereal samples.

2. RESULTS

The specific activity in Bq kg^{-1} of ^{40}K, ^{238}U, and ^{232}Th in the cereal samples investigated (as shown in a chart presented in Fig. 1) range from 0.2

Bq kg^{-1} to 186.9 Bq kg^{-1}. ^{40}K activity values range with mean value of 73.8 ± 18.4 Bq kg^{-1}. The highest value of ^{40}K was found in cowpea while soyabean has the lowest value. ^{238}U activity values range from 0.2 ± 0.1 Bq kg^{-1} to 1.4 ± 0.5 Bq kg^{-1} with mean value of 0.8 ± 0.3 Bq kg^{-1}. The highest value of ^{238}U was found in soyabean while local rice has

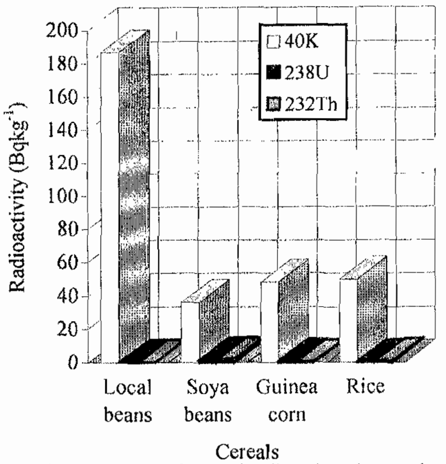

Fig.1: The distibution of natural radioactivity in cereals

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the lowest value. ^{232}Th activity values range from 0.3 ± 0.1 Bq kg^{-1} to 1.8 ± 0.7 Bq kg^{-1} with mean value of 1.1 ± 0.4 Bq kg^{-1}. The highest value of ^{232}Th was found in soyabean while guinea corn has the lowest value. ^{238}U and ^{232}Th are below the detectable limit (i.e a peak with error statement ≥ 85%) of the gamma spectrometric equipment used for cowpea. ^{137}Cs was not detected in any of the food samples.

3. DISCUSSION AND CONCLUSION

The activity of ^{40}K is generally high in all the four cereal samples considered representing about 97% of the total activity (75.7 $Bqkg^{-1}$) of the natural radionuclides. This has been attributed to natural potassium, which is an essential constituent of soils [11]. The high activity values of ^{40}K obtained for most food samples is due to its natural abundance and the contribution expected from the use of potassium based fertilizer by farmers in order to increase farm yield. The ^{238}U and ^{232}Th activity is generally low representing about 1.1% and 1.4% of the total radionuclides activity, respectively. These values could be higher relative to their expected activity in soil with the application of fertilizer. Th/U ratios for most of the food samples have been found to be less than unity. This could be attributed to their radiochemistry, ^{232}Th has only one oxidation state and could not readily form complexes with water, hence, it has very low solubility. ^{238}U has two oxidation states and could easily form complexes with water thereby enhancing its solubility. Therefore, the more from 36.4 ± 13.5 Bq kg^{-1} to 186.9 ± 23.1 Bq kg^{-1} soluble ^{238}U will easily be absorbed by the root system. The result also shows that there is no radio cesium in the food samples.

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