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Radioactivity characterization of some exported foodstuffs from Sudan

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Abstract

Radioactivity monitoring It is one of the basic prerequisites before exporting any food items according to the law of the Sudanese customs authority. Therefore, measurement of anthropogenic and natural radionuclides in some foodstuffs intended for export have been carried out. The measurement was performed using HPGe detector (High- Purity Germanium detectors) which is a type of high-resolution γ-spectroscopy . Result obtained have revealed that the activity concentration of 40K was the highest in all samples, followed by ^{238}U and ^{232}Th, whereas ^{137}Cs exhibited the lowest activity concentration. Upon comparing the average value of ^{238}U(2.37 Bq/kg),^{232}Th(1.00 Bq/kg) and ^{40}K(349.47 Bq/kg) with worldwide values reported by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). It was found they were full far below the average level of UNSCEAR with the exception eleven samples exhibited activity concentration of ^{40}K higher than an average value of UNSCEAR. Furthermore, the average value of ^{137}Cs activity concentration falls far below the international food standards limit.

Keywords: Radioactivity, Foodstuffs, γ-spectroscopy, UNSCEAR, HPGe.

Introduction

Humans prevention and safe food production are among the principal responsibilities of the legal governments in each country. The food quality can be affected by several factors and one of them is surely the level of radioactivity, particularly after a nuclear accident, such as the Chernobyl and Fukushima[1]. Anthropogenic and natural radionuclides are found in various environmental parts such as oceans, rivers, soils, rocks, vegetables and animal as well as human body[2]. The radioactive element that exists in soils and fertilizers find their way to the human body via the food chain by atmospheric distribution, gravitational settling, plant uptake and different processes[3]. Therefore, peoples and their environment are constantly exposed to these types of radiation, of which 81% can be attributed to natural radiation. The other 19% comes from artificial sources[4]. Food is one of the major roots for elements and radionuclides for people.

Hence, the assessment of radioactivity in the environment and foodstuffs extremely necessary to estimate the radiation levels to which people is exposed to either directly or indirectly[5-7]. Due to the importance of radioactivity monitoring, there are many investigations have been carried out to quantify the level of Anthropogenic and natural radionuclides in different foodstuffs around the world[8-11].

The present study was conducted as a part of the baseline survey of radioactivity level in different export foodstuff[12].

Methodology

Collection of samples: A number of 39 samples of foods (Vegetables, fruits, cereal, sesame,) were collected from Sudan Customs' storages and transported in plastic bags to the radiation detection unit (laboratory at Khartoum airport) for radioactivity measurement. The samples had been measured for radiation without any special treatment.

Radioactivity measurement: Results of the foodstuffs activity concentration measurements are the activities of ^{232}Th, ^{137}Cs, ^{40}K and ^{238}U had been determined by HPGe detector for six hours (Ortec — efficiency 40%, energy resolution 1.8 keV at 1332.5 keV). The efficiency calibration and energy of the system has been performed using a set of standards obtained from the International Atomic Energy Agency (IAEA).

The analysis of spectra had been done by the use of maestro computer software obtained from Ortec. Energy line for each activity is shown by the table below:

Activity	Energy line
^{226}Ra	^{214}Bi (609 keV) and ^{214}Pb (352 keV)
^{228}Th	1911 keV and 965 keV
^{40}K , ^{137}Cs and ^{232}Th	1460 and 661 keV

Results and discussion

Displayed in Table-1, the table shows the minimum, maximum, mean and standard deviation activity concentrations (Bq /kg) of ^{232}Th, ^{137}Cs ^{40}K, ^{232}Th and ^{238}U measured in the investigated foodstuffs samples.

The activity concentrations of ^{232}Th vary from 1.00 - 18.58 Bq /kg with an average value of 1.00Bq /kg. ^{137}Cs activity concentration was found to be in range of 0.03- 1.01 with an average value of 0.44 Bq /kg. From the obtained result the activity concentration values of ^{137}Cs fall below the limits proposed[13] by (CODEX, 2011). ^{137}Cs is an artificial product resulting from nuclear reactors, huge release of this ^{137}Cs (artificial radionuclides) found in atmosphere due to fallout activity during the Fukushima and the Chernobyl disasters[14,15]. ^{137}Cs has a half-life of 30 years..The activity concentrations of ^{40}K ranged from 0.07 to 2270.96 Bq /kg with an average value 349.47 Bq /kg. ^{238}U activity concentration, ranged from of 0.01 – 19.05 with an average value 2.37 Bq /kg. When compared to the obtained results with the world wide average recommended by UNSCEAR (2000), we have found that the average value of ^{238}U, ^{232}Th and ^{40}K are lower. However, samples, 8,9,10,11, 12,13,14,15,26 exhibited activity concentration of 40K higher than reported worldwide average value(32 Bq/kg) for ^{238}U, (30 Bq/kg) for ^{232}Th and (400 Bq/kg) for ^{40}K UNSCEAR (2000).

This can be explained by the soil ails that come as a result of an abundance of this isotope concentration[16]. Obviously, the activity concentration of ^{40}K was the highest in all samples, followed by ^{238}U and ^{232}Th, whereas ^{137}Cs exhibited the lowest activity concentration as shown in Figures-(1-4). Our findings are in good agreement with the findings of other researchers reported in the literature[3,17].

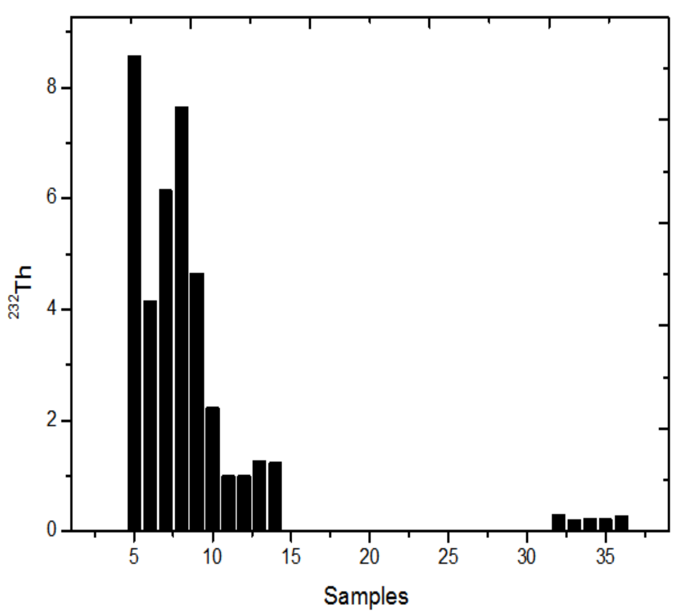

Figure-1: ^{232}Th activity concentration in foodstuffs samples.

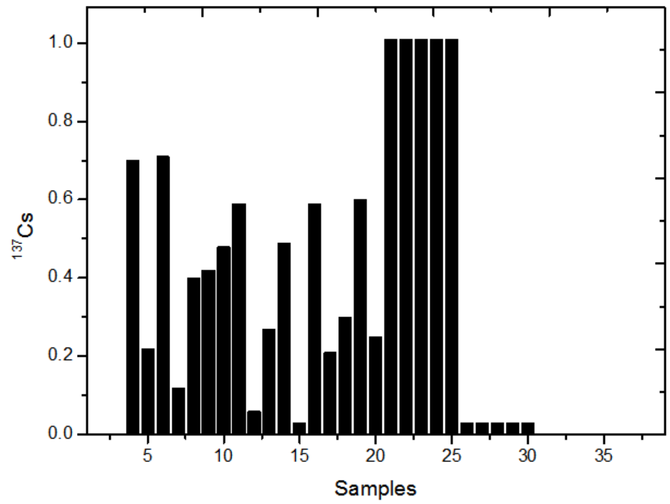

Figure-2: ^{137}Cs activity concentration in foodstuffs samples.

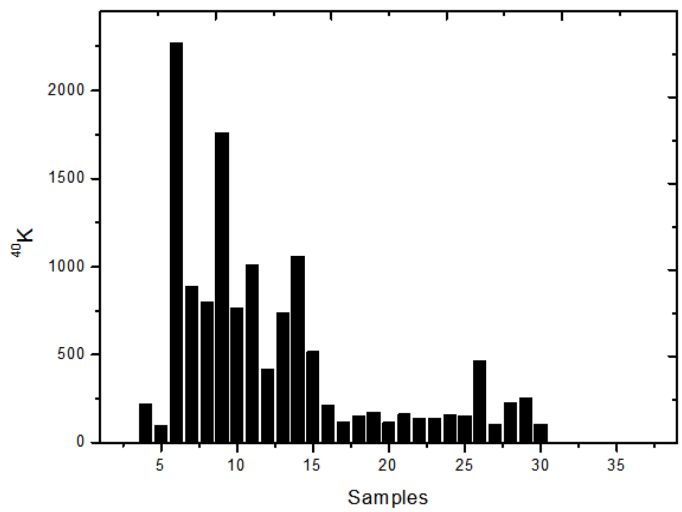

Figure-3: ^{40}K activity concentration in foodstuffs samples.

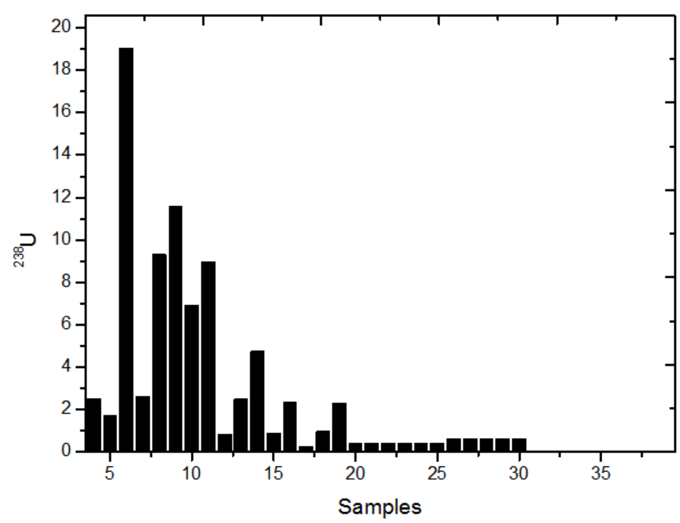

Figure-4: ^{238}U activity concentration in foodstuffs samples.

Table-1: Activity concentrations of different radionuclides in the foodstuffs samples (Bq /kg).

Samples No	^{232}Th	^{137}Cs	^{40}K	^{238}U
1	N D	0.76	211.24	3.40
2	N D	0.31	43.97	1.61
3	N D	0.40	143.00	4.12
4	N D	0.70	218.90	2.50
5	8.58	0.22	98.20	1.70
6	4.15	0.71	2270.96	19.05
7	6.15	0.12	889.76	2.63
8	7.65	0.40	800.05	9.30
9	4.66	0.42	1760.00	11.59
10	2.23	0.48	765.55	6.93
11	1.00	0.59	1012.30	8.97
12	1.00	0.06	418.50	0.85
13	1.28	0.27	740.03	2.49
14	1.24	0.49	1058.00	4.75
15	N D	0.03	516.50	0.90
16	N D	0.59	214.27	2.34
17	N D	0.21	115.99	0.28
18	N D	0.30	150.40	0.98
19	N D	0.60	174.02	2.31
20	N D	0.25	116.00	0.38
21	N D	1.01	162.40	0.41
22	N D	1.01	136.38	0.41
23	N D	1.01	140.00	0.41
24	N D	1.01	158.00	0.41
25	N D	1.01	154.00	0.41
26	N D	0.03	462.71	0.63
27	N D	0.03	106.66	0.61

Samples No	^{232}Th	^{137}Cs	^{40}K	^{238}U
28	N D	0.03	228.00	0.62
29	N D	0.03	256.00	0.63
30	N D	0.03	106.70	0.61
31	N D	N D	0.07	0.01
32	0.30	N D	0.07	0.01
33	0.21	N D	0.08	0.02
34	0.24	N D	0.08	0.01
35	0.22	N D	0.08	0.01
36	0.28	N D	0.07	0.01
37	N D	N D	0.07	0.01
38	N D	N D	0.15	0.05
39	N D	N D	0.07	0.02
min	1.00	0.03	0.07	0.01
max	8.58	1.01	2270.96	19.05
Average	1.00	0.44	349.47	2.37
Std	2.18	0.34	496.34	3.98

Conclusion

The activity concentration of ^{40}K was the highest in all samples, followed by ^{238}U and ^{232}Th, whereas ^{137}Cs exhibited the lowest activity concentration. The obtained average value of ^{238}U, ^{232}Th and ^{40}K found to be lower the average level of UNSCEAR. Some samples exhibited activity concentration of ^{40}K higher than an average value of UNSCEAR. ^{137}Cs activity concentration falls far below the international food standards limit.

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