Calculation of the Radionuclide Concentrations in Samples of Condiments by Using Gamma Spectroscopy System

Qabas A. J. Yaseen
Auday T. Subhi
Ala A. Hadi
Dept. of physics / College of Education For Pure Sciences (Ibn Al-Haitham) / University of Baghdad

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Abstract

The aim of this work is to evaluate concentrations of natural and artificial radionuclide in nine different samples of condiments from local markets.

The concentrations of ^{238}U , ^{232}Th ,^{40}k and ^{137}Cs were measured by using gamma spectroscopy with a high- purity germanium detector. The concentrations of ^{238}U, ^{232}Th ,^{40}k and ^{137}Cs were found to be in a range of (21.4 - 91.13), (15.7 - 88.11) , (285.56 – 1100) and (5.1 - 27.5) Bq.kg^{-1} respectively. These concentrations are not hazardous to public health and the activities are within the allowed levels .

Key words : artificial radioactivity , Natural radioactivity , condiments , Gamma spectroscopy .

Introduction

Natural radionuclide concentrations in environmental samples varies according to geographical and geological factors [1] and appear at different levels in soil of each region in the world [2].

Natural sources of radioactivity in the environment are called naturally occurring radioactive materials, and categorized as being of terrestrial or cosmicorigin [3].

Humans are exposed to both internal and external radiation from these natural sources. Internal exposure occurs through the intake of terrestrial radionuclides through inhalation or ingestion. Inhalation exposure does result from the existence of dust particles in the air including radionuclides from 238 U and 232 Th decay series. The biggest contribution to inhalation exposure comes from short half life decay products of radon. Ingestion exposure dose mostly results from 238 U , 232 Th series radionuclides , 40k in drinking water and food stuff. In addition 137Cs is the most important fission product released to the environment as a result of nuclear activities, because this radionuclide rapidly passes to food stuffs and creates dose effect.[4,5]

They tend to accumulate in various tissues of the human body, for instance, thorium accumulates in lung, liver and skeleton tissues, uranium in lungs and kidneys, and potassium in muscles.[6]

Materials and Methods

The samples were collected from the local markets; each of the samples was blended into powder and placed into a 0.5 L Marinelli- beaker.

Activity measurement of the samples was done by using coaxial semiconductor detector with high- purity germanium crystal which has energy resolution (2.2)keV at 1.33 MeV 60Co and detection efficiency of 50%. The detector was shielded by (10cm) of lead to achieve a background level as low as possible, and also shielded with (1mm) aluminum, (1mm) of cadmium and (1mm) of iron.

An empty Marinelli beaker (0.5L,capacity) was counted for subtracting the background Energy calibration was performed by using 152Eu source to measure the efficiency of radionuclides.

The activity of the sample (A) was measured by using the following equation :

$$S.A\ (Bq.kg^{-1}) = \frac{C}{\varepsilon .M .P\gamma}$$

Where C is the gamma ray count (number per second), ε is the detector efficiency of the specific gamma ray,Pϒ is the absolute transition probability of gamma decay and M(kg) is the mass of the sample.[7]

Results and Discussion

For the studied samples, the gamma transitions at energies 352 keV 214Pb , 609.3 keV 214Bi were used to determine the concentrations for the 238U series. The gamma transitions of energy at(238)keV 212Bi was used to determine the concentration of the 232Th series. Also 1460 keV gamma transitions of 40k and 662.keV gamma transitions of 137Cs in all of the samples were considered.

Table-1 shows the natural and artificial radionuclide activity concentrations measured in samples of condiments consumed in the regions of Iraq which are frequently consumed by local residents.

The highest concentration in the samples studied for a series of U-238 was in the form of Cumin up to 91.13 Bq.kg -1 due to geographical and geological factors of the soil and less concentration in the form of the Fenugreek by 21.4 Bq.kg -1 and the average of these concentrations by 55.86 Bq.kg-1, either for a series of Th-232 was the highest concentration is in the form of Curcuma by 88.11 Bq.kg -1 and the lowest concentration in the form of the Fenugreek by 15.7 Bq.kg -1 and the rate was up to 44.29 Bq.kg -1 , for either nuclide K-40 was the highest concentration in the form of black pepper by 1100 Bq.kg -1 and less concentration in the sample cloves up 285.56 Bq.kg -1 at a rate of 874.06 Bq.kg -1 , the highest concentration of the nuclide Cs-137 was in the form of Curcuma increased by 27.5 Bq.kg -1 and less concentration in the sample Fenugreek by 5.1 Bq.kg -1 and the rate was up to 14.04 Bq.kg -1.

Conclusion

Calculation of the concentration for natural and industrial radioactive elements samples condiments the consumed frequently in the local markets in Iraq , the results of concentrations that is found in the proportion of medium and within the allowable limits , and figures from 1 to 4 show concentrations for ^{238}U, ^{232}Th, ^{40}k and ^{137}Cs in the samples .

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Table No. (1) : Concentrations of radioactive elements ^{238}U , ^{232}Th , ^{40}k and ^{137}Cs in sample of condiments

Sample No.	Sample	Origin	S.A (Bq.kg $^{-1}$)			
			^{238}U	^{232}Th	^{40}K	^{137}Cs
1	Rosemary	Syrian	67.92	72	887.8	12.78
2	Cinnamon	Syrian	61	19.5	571.13	8.57
3	Curcuma	Indian	51.05	88.11	1078.2	27.5
4	Coriander	Iraqi	57.17	69.9	934.5	20.1
5	Cumin	Iraqi	91.13	20.64	1099.5	12.85
6	Cloves	Iraqi	55.07	25.66	285.56	12.78
7	Nutmeg	Syrian	32.69	64.04	778.81	18.77
8	Fenugreek	Iraqi	21.4	15.7	771.02	5.1
9	Black-pepper	Indian	65.39	23.09	1100	7.99
	average		55.86	44.29	874.06	14.04

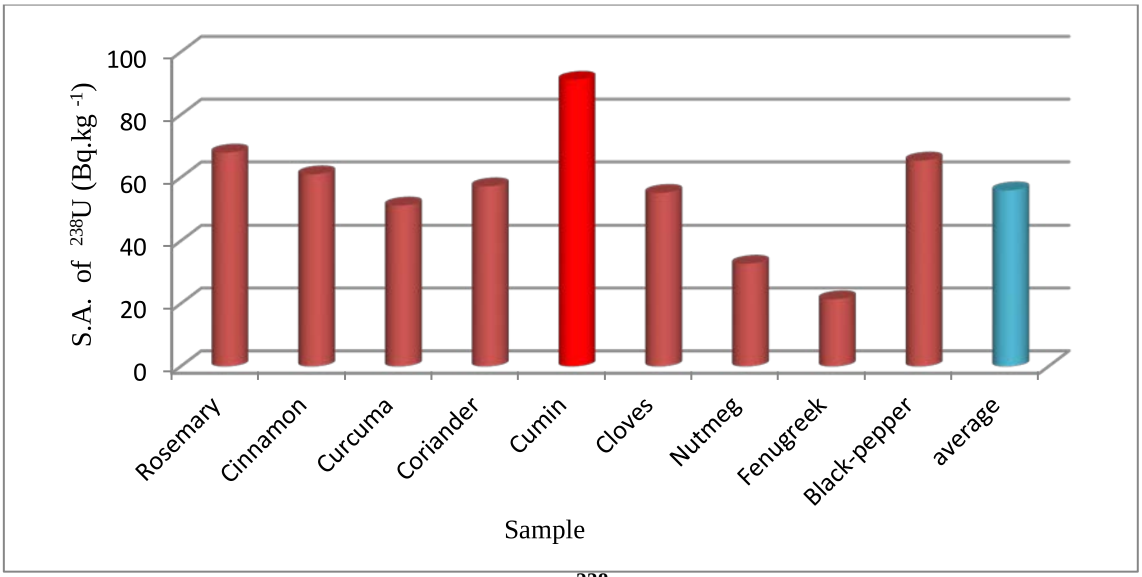

Figure No. (1) The concentration of ^{238}U for the samples of condiments.

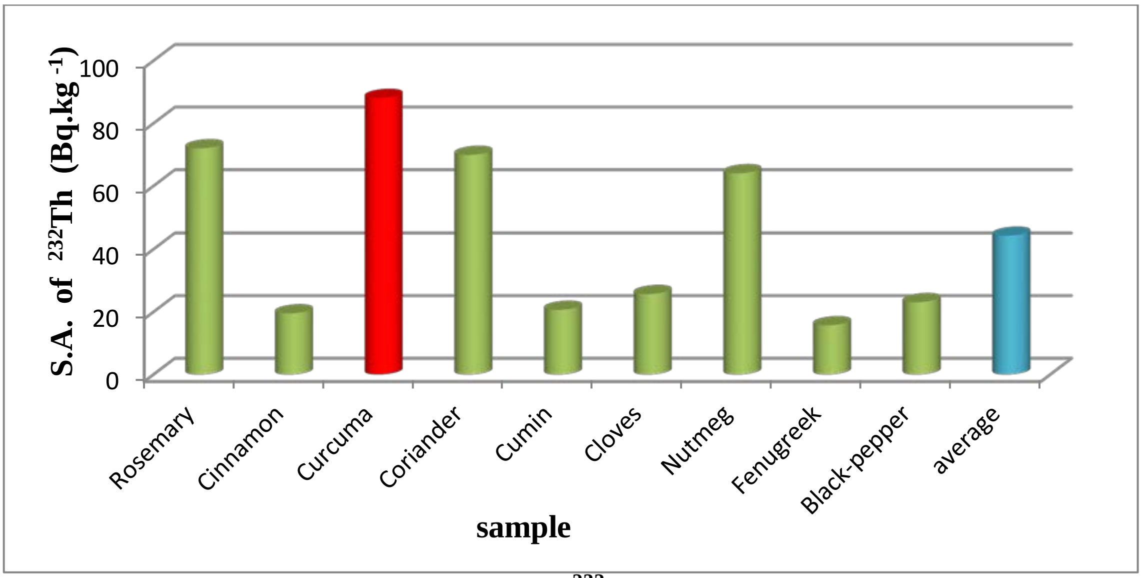

Figure No. (2) The concentration of ^{232}Th for the samples of condiments

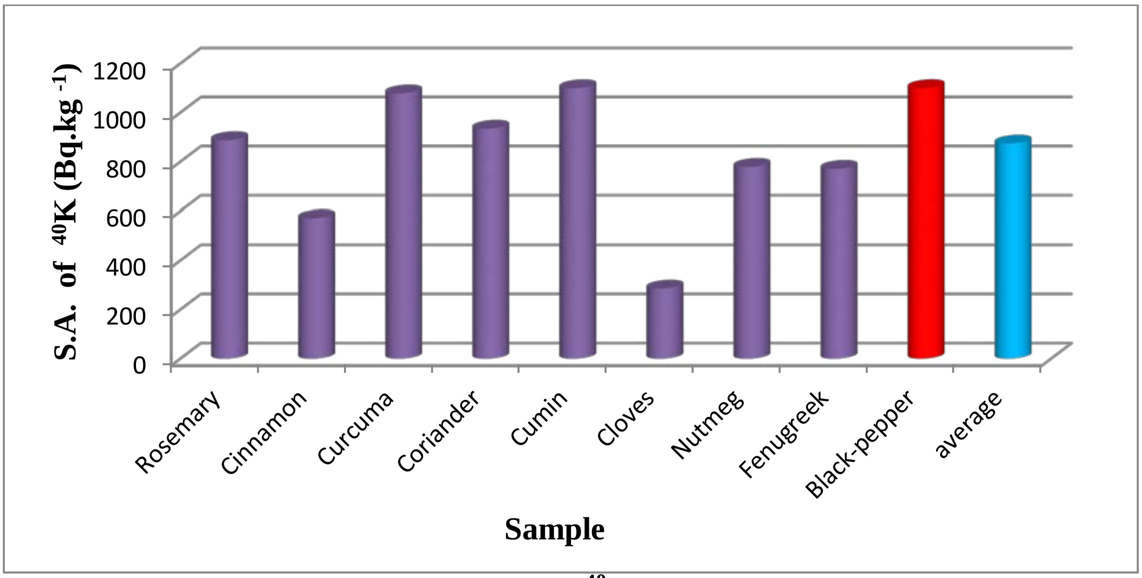

Figure No. (3) The concentration of ^{40}K for the samples of condiments

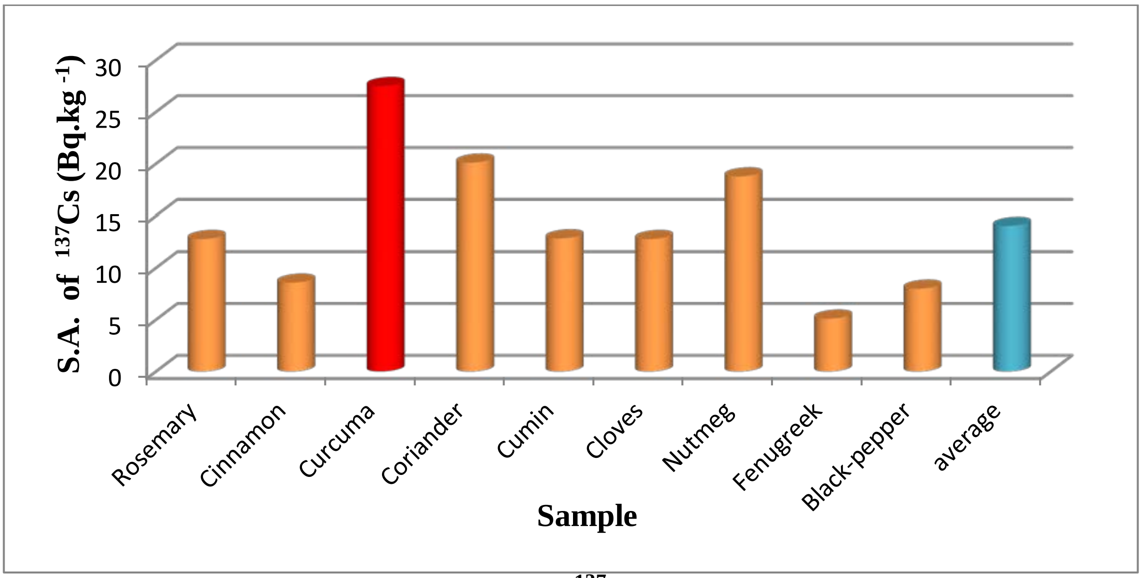

Figure No. (4) The concentration of ^{137}Cs for the samples of condiments

حساب تراكيز النويدات المشعة في نماذج من التوابل باستعمال مطيافية اشعة كاما

قبس عبد الجبار ياسين
عدي طارق صبحي
علاء عبد هادي
قسم الفيزياء / كلية التربية للعلوم الصرفة (ابن الهيثم) / جامعة بغداد

استلم البحث في 7كانون الثاني 2012 ، قبل البحث في ايار 2013

الخلاصة

تم في هذه الدراسة حساب تراكيز النويدات المشعة الطبيعية والصناعية في تسعة نماذج من التوابل الموجودة في الاسواق المحلية.
استخدمت لهذا الغرض منظومة مطيافية اشعة كاما مع كاشف الجرمانيوم العالي النقاوة (HpGe) لقياس تراكيز النويدات المشعة ^{238}U و ^{232}Th و ^{40}K و ^{137}Cs في التوابل .
كانت تراكيز اليورانيوم- 238 تتراوح بين (21-91.03) بكرل / كغم ، و للثوريوم – 232 بين (15.7-88.11) بكرل / كغم
وللبوتاسيوم – 40 بين (1100 - 285.56)بكرل / كغم ، وللسيزيوم (27.5 - 5.1)بكرل / كغم .
نستنتج من هذه القيم ، انها مستويات اشعاعيه لاتشكل خطورة على الفرد العراقي وكانت ضمن المستويات المسموحة .

الكلمات المفتاحية :- النويدات المشعة الصناعية ، النويدات المشعة الطبيعية ، مطيافية كاما ، التوابل .