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Measurement of radionuclides in imported Coffee Consumed in Basra southern of Iraq and estimation of its annual effective dose

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Abstract:

Radioactive elements were identified in samples of imported coffee consumed in the province of Basra using gamma spectrometry SAM940^{TM}. It is a scintillation detector of NaI(Tl) crystal and the dimensions of 2×2 inch. We have identified specific concentration A_s(Bq/kg) and annual effective dose D(Sv/y) for radioactive elements ^{40}K, ^{131}I, ^{134}Cs and ^{137}Cs. The estimated average effective dose for adults from coffee samples were found to be 0.037mSv/y, 88.434nSv/y, 46.909nSv/y, 27.212nSv/y for (^{40}K, ^{131}I, ^{134}Cs, ^{137}Cs) respectively. The present results of the study revealed that the radioactivity was relatively low in the coffee and within the permissiblelimit.

Key worlds: Coffee, SAM940 identifer, gamma ray, radionuclide.

Introduction:

Radiation in the environment classified into two types of natural radiation is natural occurring radioactive matter in the environment, and industrial radiation; the natural radiation is split into two rays of cosmic and terrestrial radiation [1]. The cosmic rays cause, is outside of our solar system, any stars and little ones of our solar system [1,2]. The radiation sources in the terrestrial radiation include ^{238}U and ^{232}Th decay series.They found an abundance in rocks, soil, food, water and air are causing radon gas and thoron[3]. The ^{235}U decay series its half- life 7.1×10^{8} years, called actinium series and half-life for ^{238}U and ^{232}Th are $4.5\times 10^{9}, 1.4\times 10^{10}$years respectively [4]. As well as some of the elements that non-series for example ^{40}Kwhich half-life 1.28×10^{9} years and found an abundance in rocks, food and water [3]. The industrial sources of radiation it may significant impact on the pollution of the environment and through multiple domains. The most important of radiation resulting from nuclear experiments and the use of radioisotopes in industry, agriculture, scientific research, medicine, fuel cycle in terms of mining, mineral processing, nuclear fuel and radioactive waste storage address[1].

Materials and methods:

1-Sampling preparation

Coffee samples collected from the Basra local market, Ten different brands that originated from 8 different countries were selectedand listed in Table (1).

Each sample was grinded very fine. Fifty gram of each sample was placed in a plastic can of 10 cm height and 4.6 cm diameter. The can was placed in the detectorsystem counted for 1200 second.

Table (1):Represents samples of coffee for different production countries.

Sample code	Sample Name	Production
S1	NESCAFE CLASSIC	Brazil
S2	COFFEE golden	Brazil
S3	NESCAFE CLASSIC	Spain
S4	City Cafe	European Union
S5	BON AROMA	Poland
S6	Arabica	Lebanon
S7	Bon nagar	Lebanon
S8	Bon al hamwi	Syria
S9	Coffee prince	Jordan
S10	Mac Coffee	Singapore

2-Measurements

Measurement were performed using a SAM940^{TM}gamma ray spectrometer. This system hasNaI(Tl) crystallization 2× 2 inch with 256 channel, the detector measures the spectrum emitted from radioactive isotopes and low level Becquerel measurement.The device works at operation voltage of 600 volts. It is of coarse gain=1 , fine gain=1.1386, upper level discriminative= 100 volts and lower level discriminative=0.8 volts. The detector was calibrated by standard radioactive elements ^{137}Cs which has the energy of 661.660 keVphotopeak , ^{133}Ba with energies of (53.161,80.997, 160.613, 302.853, 383.851)keV photopeaks, and ^{60}Co which has the energies of (1173.238,1332.502)keV.

The detector was shielded lead and copper cylinder as shown in figure (1), which represents the measurement system. Efficiency Ɛ of each gamma energy specified in the calibration source was calculated using the formula [5]

$$\mathcal{E} = \frac{\sum N}{A \quad P_{\gamma} t m} \qquad \ldots\ldots(1)$$

Where ΣN is the net counts of the corresponding photopeak, A is the activity in Bq, P_{γ} is the emission probability per disintegration [6], (t) is the counting time in seconds and (m) is the mass sample (kg).

Fig. (1):SAM940^{TM} gamma ray spectroscopy system.

3- Activity concentrations

The activity concentrations in the samples was obtained using the following expression [3,5,7]

$$A_S = \frac{\sum N}{\varepsilon t m P_{\gamma}} \qquad \ldots(2)$$

Where A_S (Bq/kg) is the activity concentration of nuclides in the coffee samples.

4- Annual effective dose

The annual effective dose from consumption of coffee is calculated using the formula [8]

$$D = A_S \, U \, g \qquad \ldots(3)$$

Where D is the annual effective dose (Sv/y), A_S is the activity concentration for the radionuclide (Bq/kg), U is the annual intake of coffee (kg/yr); the normal consumption of coffee will be (5-10) gram per day [9], and g is dose conversion factor for the radionuclide (Sv/Bq). It was calculated according to ICRP [10] for intake by ingestion of radionuclides.

Results and Discussion:

Table (2) presents the activity concentration for ^{40}K, ^{131}I, $^{134}Cs$and ^{137}Cs in the coffee samples.^{40}K was detected in all samples with a maximum value of 54.765 Bq/kg in samples (S2,S3,S5), and a minimum value of 24.841 Bq/kg in sample S4with an average value of 49.695 Bq/kg.^{131}I was detected in five samples with a maximum value of 0.055Bq/kg in sample S1, and a minimum value of 0.018 Bq/kg in sample S4with an average value of 0.036 Bq/kg. ^{134}Cs was detected in nine samples with a maximum value of 0.049 Bq/kg in sample S8, and a minimum value of 0.004Bq/kg in sample S9 with an average value of 0.021Bq/kg. ^{137}Cs was detected in three samples with a maximum value 0.020Bq/kg in sample S5, and a minimum value of 0.016Bq/kg in samples (S9,S10) with an average value of 0.018Bq/kg. Fig (2) shows the spectrum of sample S5.

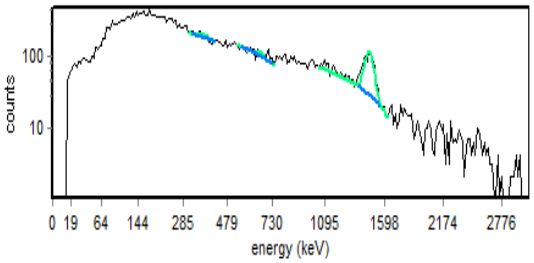

Fig. (2): spectrum of sample S5.

Table (2):Measurement of Activity concentrations of radionuclide in coffee samples.

A_s(Bq/kg)				
samples	^{40}K	^{131}I	^{134}Cs	^{137}Cs
S1	54.384	0.055	0.011	ND
S2	54.765	ND	0.011	ND
S3	54.765	0.026	0.019	ND
S4	24.841	0.018	0.030	ND
S5	54.765	0.029	ND	0.020
S6	54.232	ND	0.023	ND
S7	54.308	0.051	0.030	ND
S8	36.507	ND	0.049	ND
S9	54.079	ND	0.004	0.016
S10	54.308	ND	0.008	0.016
Ave.	49.695	0.036	0.021	0.018
		ND:- not detected		

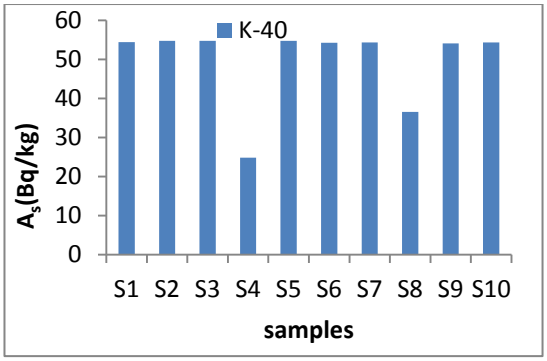

Fig.(3):Activity concentrations of ^{40}Kin coffee samples.

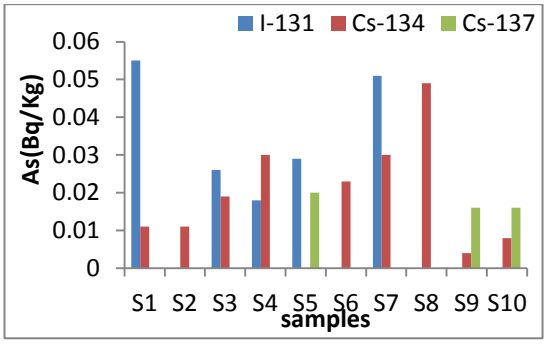

Fig.(4):Activity concentrations of ^{131}I, ^{134}Cs, ^{137}Csin coffee samples.

Table (3) presents the annual effective ingestion dose for adults for ^{40}K, ^{131}I, $^{134}Cs$and ^{137}Cs in coffee samples. Where the$^{40}K$was of a maximum value 0.041mSv/y in samples (NESCAFE CLASSIC and COFFEE golden products in Brazil, NESCAFE CLASSIC product in Spain BON AROMA product in Poland),and a minimum value 0.019mSv/yin sample City Cafe product in European Union, with an average value of 0.037mSv/y. $^{131}I$with a maximum value 144.672nSv/y in sample NESCAFE CLASSIC product in Brazil, and a minimum value 48.206nSv/y in sampleCity Cafe product in European Union, with an average value of 88.434nSv/y.^{134}Cs with a maximum value 111.940nSv/y in sample Bon al hamwi product in Syria, and a minimum value 8.618nSv/yin sample Coffee prince product in Jordan with an average value of 46.909nSv/y.^{137}Cs with a

maximum value 31.403nSv/y in sample BON AROMA product in Poland, and a minimum value 25.116nSv/y in samples (Coffee prince product in Jordan and Mac Coffee product in Singapore) with an average value of 27.212nSv/y.

Table (3):Annual effective dose for adults.

D (Sv/y)adults				
Samples	$^{40}K \times 10$	$^{131}I \times 10$	$^{134}Cs \times 10$	$^{137}Cs \times 10$
S1	0.041	144.672	25.855	ND
S2	0.041	ND	25.855	ND
S3	0.041	67.478	43.092	ND
S4	0.019	48.206	68.856	ND
S5	0.041	77.088	ND	31.403
S6	0.040	134.930	51.756	ND
S7	0.040	ND	68.856	ND
S8	0.027	ND	111.940	ND
S9	0.040	ND	8.618	25.116
S10	0.040	ND	17.328	25.116
Ave.	0.037	88.434	46.909	27.212
		ND:- not detected		

One can conclude from the above results, that the average annual dose from ^{40}K is below the reference value of 1.0 mSv/y according to the ICRP publications. The estimated annual effective dose for radionuclides was much below, than the reference value of (200-800) μSv/y according to the UNSCEAR 2000 report [11].

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قياس فعالية النظائر المشعة في القهوة المستوردة المستهلكة في البصرة جنوب العراق و تحديد الجرع السنوية الفعالة

علي عبد عباس **عبدالمنعم خليل ابراهيم** **مروة جواد كاظم**

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الخلاصة:

تم تحديد العناصر المشعة في عينات القهوة المستوردة المستهلكة في محافظة البصرة بواسطة مطيافية اشعة كاما SAM 940^{TM} والمتكون من كاشف أيوديد الصوديوم المشوب بالثاليوم(NaI(Tl ذا حجم 2 ×2 انج. تم قياس التركيز النوعي(بيكرل/كيلوغرام) و الجرعة السنوية المؤثرة (سيفرت /السنة) للعناصر المشعة ^{40}K، ^{131}I، ^{134}Cs، ^{137}Cs. و حساب معدل الجرعة السنوية المؤثرة للبالغين في نماذج القهوة و كانت (0.037 ملي سيفرت/سنة، 88.434نانوسيفرت/سنة، 46.909 نانوسيفرت/سنةو 27.212 نانوسيفرت/سنة) للبوتاسيوم ^{40}K،لليود ^{131}I، للسيزيوم ^{134}Cs فضلاً عنالسيزيوم ^{137}Csعلى التوالي و كانت النتائج دون الحد المسموح به عالمياً.

الكلمات المفتاحية: القهوة، منظومة المعرِّف سام-940، نويدة مشعة.