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The Effective Dose Equivalent for potassium K^{40} in Cow's Milk of Salah-Din Governorate/ Iraq

Mahdi S. Hamad *;

Yasir K. Mohammad

Tikrit University, College of Dentistry, Basic Science

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ABSTRACT

Radioactivity was measured for 170 cow's milk samples in Salah-Din governorate. Samples were measured by a gamma spectrometry system, using a high purity germanium (HPGe) detector. The detector was shielded by 10 cm all sides with cadmium copper in the inner sides. The selected characteristic gamma peaks for the detection of different ware 1460kev for K-40. The energy calibration was performed using a set of standard gamma ray calibration sources Eu-152.

The results of show the presence of in all samples of milk.

The maximum radioactivity was seen in Baiji city was (424 Bq/kg), while the minimum was seen in Abayaji (256 Bq/kg) and the average of all samples was (341.3 Bq/kg) and the annual effective dose was 0.302`mSv/y.

That considered as the annual limit of rang of public recommended by the FAO

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INTRODUCTION

After the events of the Grenoble reactor, the world was shocked by the acute and painful effects of environmental disasters. These disasters include the presence of radioactive sources in food and their effects on human health and safety (Hisamatus and Takizawa, 1990). Humans, animals and plants are also exposed to radiation directly through the process of external exposure to radioactive material deposited on the ground, or as a result of the inhalation n of suspended radioactive materials in the atmosphere and transported by dust storms to long distances and different directions (Richon, et al, 2010). The indirect way of receiving radiation is through food and water containing radioactive material (Desai and Vanitaben, 2014). Some radioactive isotopes cause soil and plants enterd the human body or animal through the food chain, and the radioactive material from the soil to the plant tissue is displaced by the root during the metabolic processes carried out in the papers (Al-Hakim, 2001). There are many several factors contributing to the problem of food contamination of radioactive materials, including the presence of many radioisotopes with distinct physical and chemical properties (Desai and Vanitaben, 2014 and Hisamatus and Takizawa, 1990). The effect of radioisotopes varies according to these characteristics; the sedimentation period of radioactive materials plays a major role in increasing their impact on soil and food contamination (Marouf, et al, 1991). In addition, there are major reasons for the environmental pollution of radioactive materials, such as experimental nuclear explosions and radiation accidents, which eventually lead to exposure to external or internal doses, even if they are weak, but exposure to this dose leads to a high cumulative dose of significant health benefits (Wara-aswapati et al, 2005). The methods of detection

* *Corresponding author: E-mail*: mahdis.hamad@tu.edu.iq

and measurement depend on the quality and quantity of radiation on the effect of this radiation on the material there are many studies on the content of radioactive materials, including K40 potassium which detector by use of high-grade germanium detector (HPGe) (Al-Baroudi, 2004). The cans used to store food or substances are a container of nitrates or potassium nitrate they may be radioactively contaminated or from highly radioactive areas (Hayball, et al, 1989). Potassium is found in nature in the form of three isotopes, the most important of which is K^{40}. It is a semi-stable equilibrium between these isotopes it is about 1.30x109 year. Potassium K^{40} dissolves to give calcium Ca^{40} with beta emissions (Salloum, et al, 2017). The reaction of the families with Gama emission is K^{40}. (0.0177%) of natural potassium approximately (29.6Bq.gm^{-1}). Potassium is transferred to the human through the digestive system. The amount of natural potassium in the human body 70Kg is estimated to be approximately 140 gm 370Bq of K^{40}. Therefore, K40 is the most natural element in the radioactive dose of humans. Chemically they can compete with each other as they move from the soil to the next plant of man (Al-Ahmad, 1993 and Wara-aswapati, et al, 2005).The table (1) represents the most important sources of natural exposure, namely potassium (K^{40}).An annual dose equivalent of normal radiation background. (Al-Rawas, et al, 2016).

Table (1) the most important sources of natural exposure, namely potassium (K^{40})

Sources of radiation	Annual dose equivalent (μSv / year)	
	Internal exposure	External exposure
Ionizing radiation and neutron		300
Cosmic rays	15	
K^{40}	180	120

The methods of detection and measurement depend on the type and quantity of radiation and the effect of these rays on the materials. There are several scientific and local studies, which dealt with many types of milk and detected the emergence of Potassium-40 in all these samples, and consumption of local and imported foods during these years did not cause doses Radiation beyond internationally recommended limits (Abdul-Fattah and Abdul-Majid, 1995, Altzitzoglou and Bohnstedt, 2008, Hosseini, et al, 2006, and Shukla, et al 1994).

The aim of this research is to determine the extent of exposure caused by ingestion of milk as well as to monitor the radioactive contaminants in these foods to ensure their suitability for human consumption.

Method

The Gama spectra analysis system was used to measure radioactivity in milk. The system consists of a high-purity germanium reagent (HPGe) of 10 cm in cadmium copper connected to a 661Kev multichannel separation analyzer at the Cs-137 and 1460Kev spectra of the K-40 counterpart. The system has been calibrated with a standard EM- Radioactivity of standard source and food models. A temperature oven of 100C was used to dry our samples. The time of measuring each sample within the system used was 3600 Second to get the best result. Local farms have been used to obtain samples. The samples were collected according to the recommendations of the International Atomic Energy Agency (IAEA). The radioactivity of the soil between (388-621 Bq / Kg) and the plants between (273-568 Bq / Kg) and Table (2) shows the radioactivity of these models.

Table (2) Radioactivity rate in milk samples

Location sample	Code sample	Number of samples	The radioactive efficacy of potassium in milk Bq / Kg		
			High	Low	average
Tikrit	S1	9	421	351	387
Balad	S2	14	363	283	318
Samara	S3	11	390	267	320
Dujail	S4	13	370	263	310
Abayaji	S5	12	375	256	305
Dulyaia	S6	16	365	252	311
Ethrib	S7	12	388	279	351
Eshage	S8	11	365	294	320
Muatsim	S9	13	330	272	302
Dur	S10	10	405	348	370
Tuz	S11	11	387	320	351
Sharqat	S12	12	419	352	393
Baiji	S13	11	424	376	396
Alam	S14	15	367	312	344
Average					341.3

RESULT AND DISCUSSION

The results of the laboratory analysis showed that there is a radioactivity of K^{40} for all models, ie, this analog is prevalent in most food. Therefore, most radiation doses of the population result from eating the food as shown in tables (2).

Based on data available to the Central Bureau of Statistics, the total consumption of imported foodstuffs by Iraqi citizens is 95% and 5% are dependent on local cow's milk and other foods (HSS, 2009). Food items also contain normal K^{40} radiation activity, and in some cases radioactive radionuclides from the U^{238} series, particularly Ra^{226} (UNSCEAR, 2000).

In other words, contamination of food can occur as a result of environmental sources such as the contents of the preservative case (USEPA, 1997). Due to the absence of radioactive contamination in the studied models and the detection of the C^{137} industrial, which is one of the most dangerous radioactive isotopes that enter the food chain through nuclear accidents, it remains in the environment and the human body for a long period where the half-life 30 years (Hassan, et al 2010).

The annual equivalent dose of exposure was calculated using the equation

$$D_m = C_m . CR_m . D_{cm} \qquad \dots 1$$

Where:

D_m, Annual equivalent dose Sv/y

C_m, Concentration of potassium in milk Bq/kg

CR_m, Amount of consumption 110 kg/y

D_{cm}, potassium conversion factor 0.4×10^{-6} mSv /Bq

Many studies were conducted in Iran, Saudi Arabia and India on many types of food for adults and children and found that 100% of the material is in the K^{40} in food and milk and concentrations ranged between (101-393 Bq / Kg) and 24% It contained a C^{137} equivalent and a concentration of 0.1-1.02Bq / Kg in the non-Ra ^{226} in Saudi Arabia (Abdul-Fattah and Abdul-Majid, 1995).

It was found that 92% of the substances contained K^{40} for food and milk at a concentration ranging between 112-413 Bq / Kg and 33% containing Radium -226 and a concentration of 0.1-15.4Bq / Kg. 15% of which contained Cs^{137} and a concentration of 0.1-2.08Bq / Kg in Iran (Hosseini, et al, 2006).

In addition, 99% of the substances contained K^{40} for food, milk and infant formula, with a concentration ranging from 187-424 Bq / Kg. 42% contained the Ra^{262} and a concentration of 0.1-

3.434Bq / Kg), 5% of which contained C^{137} and a concentration of 0.1-0.442Bq / kg in India (Shukla, et al, 1994). Table (3) shows the highest concentrations of K^{40} in milk in the current study and global studies

Table (3) shows the highest concentration of K^{40} in milk in some countries

In the study	Saudi Arabia	Iran	India	Iraq
341 Bq/Kg	393 Bq/Kg	413 Bq/Kg	424 Bq/Kg [	327 Bq/Kg (Hassan, et al 2010)

Therefore, countries concerned with the environmental control of food imports to ensure that they are free from any radiation activity and set standards that control the radioactive contaminants that accompany some foodstuffs so that the dose is exposed within the recommended limits and the special standards that comply with the requirements of the International Atomic Energy Agency and bound Global health without hindering the movement of world trade and food trade among the countries of the world. Table 4 shows the limits for food contamination by radioisotopes in some countries depending on socio-economic conditions in units (Bq / kg) (Hassan, et al, 2010).

Table (4) shows the limits for food contamination with radioisotopes in some countries (Bq / kg)

Subject	Syria	Egypt	Europe	USA	Iraq
Baby milk	15	370	370	370	30
Baby food	15	370	600	370	30
Other food	150	600	600	370	370

It is clear that the effectiveness of potassium in milk ranged between the highest value (424 Bq / kg) in the site (Baiji) and the lowest value (256 Bq / kg) in the site (Abayaji) and mean values for all samples (341.3 Bq / kg). Potassium is one of the basic mineral elements in milk synthesis (Al-Dabbagh. 2013). It is noted that the effectiveness of potassium in milk seems to approach the calculated value of studies (Abdul-Fattah and Abdul-Majid, 1995, Hosseini, et al 2006 and Shukla, et al 1994). The transfer of potassium from soil to plant depends on many factors, especially the nature of the plant and the state of germination and climatic conditions of the amount of water, heat and wind, and most important is the soil content of the basic mineral elements and the amount needed by the plant (Al-Baroudi**,** 2004).

CONCLUSIONS

1- The concentrations of potassium K40 in Cow's Milk of Salah-Din Governorate (424 Bq/kg-256 Bq/kg)
2- Milk samples in Salah-Din Governorate safe from the radiation a special potassium because the annual effective dose was 0.302`mSv/y

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الجرعة المؤثرة المكافئة للبوتاسيوم K^{40} في حليب الابقار في محافظه صلاح الدين / العراق

مهدي صالح حمد وياسر خلف محمد

كلية طب الأسنان/فرع العلوم الأساسية/ جامعة تكريت

المستخلص

تم قياس النشاط الإشعاعي ل 170عينة مختلفة من حليب الابقار في محافظه صلاح الدين. استخدمت منظومة تحليل أطياف كاما لقياس النشاط الإشعاعي لنماذج الحليب. وتتكون المنظومة من كاشف الجرمانيوم ذو نقاوة عالية (HPGe) محمي من الجوانب بـ 10 سم بنحاس الكادميوم ومرتبط بمحلل متعدد القنوات القابلة الفصل عند الطاقة 1460 كيلو الكترون فولت لنظير البوتاسيوم− 40. تم معايرة المنظومة بمصدر قياسي لأشعة كاما Eu-152 استخدم لقياس النشاط الإشعاعي للمصدر القياسي لنماذج الحليب.

أظهرت نتائج التحليل ألمختبري وجود نشاط إشعاعي لنظير البوتاسيوم− 40 في جميع نماذج الحليب.

اذ كان اعلى نشاط اشعاعي في منطقه البيجي اذ بلغت 424 كيلوبكرل / كغم واقل نشاط في منطقة العبايجي وبلغ 256 كيلو بيكرل/كغم وكان معدل النشاط الاشعاعي 341.4 كيلوبكرل / كغم، وكانت الجرعة الفعالة 0.302 ملي سفرت في /سنه

والتي تبقى ضمن الحدود المسموح بها حسب توصيات المنظمة الدولية للأغذية العالمية

الكلمات المفتاحية: الجرعة الفعالة، النشاط الاشعاعي، نظير البوتاسيوم، حليب الابقار .