Radioactivity and annual effective dose in some types of drug

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Abstract

The aim of this research is to know danger of radioactive isotopes that are found in samples of drugs traded in Iraqi markets. The samples are Iraqi Amoxicillin, English Amoxicillin, UAE Amoxicillin, Indian Amoxicillin, Iraqi Paracetamol, English Paracetamol, UAE Paracetamol and Indian Paracetamol. By high purity germanium the activity of the following isotopes ^{40}K, ^{214}Pb, ^{228}Ac and ^{137}Cs is measured and the specific activity was used to calculate the annual effective dose. Then the calculated annual effective dose values are compared with the allowable annual effective dose values of each part of digestive channel. This research concluded that the measured annual effective dose values are not dangerous.

Key words

Specific activity, annual effective dose, radioactive nuclides.

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الفاعلية النوعية والجرعة المكافئة السنوية في بعض عينات الادوية

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الخلاصة

الهدف من هذا البحث هو معرفة خطر النظائر المشعة الموجودة في عينات من الادوية الموجودة بالاسواق العراقية. وهذه العينات هي الاموكسسلسين العراقي، الاموكسسلين الانكليزي، الاموكسسلين الاماراتي، الاموكسسلين الهندي. كذلك البراسيتول العراقي، البراسيتول الانكليزي، البراسيتول الاماراتي، البراسيتول الهندي. بواسطة كاشف الجرمانيوم عالي النقاوة تم قياس الفاعلية النوعية للنظائر الاتية ^{40}K، ^{214}Pb، ^{228}Ac، ^{137}Cs ثم استخدمت الفاعلية لحساب الجرعة المكافئة السنوية. وقد قورنت الجرع المكافئة السنوية المحسوبة مع الحد المسموح للجرعة المكافئة السنوية لكل جزء من القناة الهضمية واتضح انها ليست جرع خطرة.

Introduction

The exposure of human existence to radiation from things that is inevitable because all that is around us contain radioactive nuclide in different rates. The radioactive sources are divided to natural and artificial sources [1]. It is about 80% from human exposure comes from natural sources [2, 3]. Those sources are atmosphere as a result of cosmic rays comes from outer space [1]. Earth is also considered as a source of radionuclide, all the geological formations such as soil, rocks and the core of the earth [4, 5]. Since the petroleum derivatives extract from the core of the earth, therefore, they contain on radioactive nuclides [6]. Human body contains on radioactive nuclides, where there is about 0.0157 g from radioactive isotope in human body and its activity about 0.11μCi [7]. The artificial radioactive sources come from human activities, weapons and nuclear accidents like Chernobyl power station accident in 1986 [8, 9].

In the present paper the existence of specific activity and annual effective dose in some types of drug samples

was studied to make sure that these drugs don't pose danger to the human health. The samples are anti-inflammatory and relievers drugs because they are of the most drugs commonly used. It has been selected Amoxicillin and Paracetamol from four origins which Iraqi, English, Indian and United Arab Emirates, because they are the most actively traded in the Iraqi market if they compare with others origins.

Materials and method

Four samples of Amoxicillin and four samples of Paracetamol were made in different contrary. The tablets have been grinded and put in high purity germanium detector that is available in Radiation protection center for one hour in order to measure the radioactive isotopes concentration. Since the less mass which can detector tests it is 9 g, therefore, the mass must be placed in detector is 9 g or more.

Results and discussion

In order to know the risk of radioactive isotopes in drug samples, the annual effective dose must be measured and compared with the allowed dose for each part of human body.

The allowed dose for, mouth, throat, gullet and brain is 0.05 Sv and for stomach is 0.12 Sv [10]. The annual effective dose was calculated from equation

$$D = RAeM \quad (1)$$

where R is radiation weighting factor which represents the number by which the absorbed dose in a tissue or organ is multiplied to reflect biological effectiveness of the radiation in inducing stochastic effects at low doses. Its value is one for photons [11]. A (Bq/kg) is specific activity, e (Sv/Bq) is a conversion factor from activity to dose are given in Table 1 for different isotopes [10] and M (kg/y) is the intake per year. The mass M was calculated from multiplying tablet mass by number of tablets per day which is considered four for Amoxicillin and three for Paracetamol and the result multiplied by number of days per year.

Table 1: The conversion factors of the isotopes found in samples [10].

Isotope	Conversion factor (Sv/Bq)
^{40}K	6.2×10^{-9}
^{214}Pb	1.4×10^{-10}
^{228}Ac	4.3×10^{-10}
^{137}Cs	1.3×10^{-8}

The isotopes ^{40}K, ^{214}Pb, ^{228}Ac and ^{137}Cs are found in drug samples in different rates as it is shown in Tables 2.

Table 2 gives the specific activity and the annual effective dose values for ^{40}K. The average value of specific activity was 7.047 Bq/kg, the maximum value was 19.08 Bq/kg for Iraqi Paracetamol, while the minimum value was 1.4 Bq/kg for UAE amoxicillin. For annual effective dose one can see that the average value was 29.898×10^{-9} Sv the maximum value was 77.7×10^{-9} Sv for Iraqi paracetamol and the minimum value was 6.33×10^{-9} Sv for UAE amxicillin.

Table 2: Specific activity, sample mass, in take mass per year and annual effective dose of ^{40}K for all samples.

Sample	Specific Activity (Bq/kg)	Sample mass (g)	In take per year (kg/y)	Annual Effective Dose (Sv)
1-Iraqi Amoxicillin	2.8	0.3g	0.438 kg	$7.6x10^{-9}$
2-English Amoxicillin	2.8	0.6g	0.876 kg	$15.21x10^{-9}$
3-UAE Amoxicillin	1.4	0.5g	0.73 kg	$6.33x10^{-9}$
4-Indian Amoxicillin	10.7	0.5g	0.5 kg	$48.8x10^{-9}$
5-Iraqi Paracetamol	19.08	0.6g	o.657kg	$77.7x10^{-9}$
6-English Paracetamol	5.5	0.7g	0.7665kg	$26.13x10^{-9}$
7-UAE Paracetamol	12	0.6g	0.657kg	$48.88x10^{-9}$
8-Indian Paracetamol	2.1	0.6g	0.657kg	$8.55x10^{-9}$
Average	7.047			$29.898x10^{-9}$

Table 3 shows the specific activity and the annual effective dose values for ^{214}Pb. It is noticed that the average value of the specific activity was 0.535 Bq/kg, the maximum value was 0.83 Bq/kg for UAE paracetamol and the minimum value was 0.23 Bq/kg for Iraqi amoxicillin. The average value of the annual effective dose was $0.53x10^{-10}$ Sv, the maxium value was ($0.88x10^{-10}$ Sv) for English amoxicillin and the minimum value was $0.313x10^{-10}$ Sv for Iraqi paracetamol.

Table 3: Specific activity, sample mass, in take per year and annual effective dose of ^{214}Pb for all samples.

Sample	Specific Activity (Bq/kg)	Sample mass (g)	In take mass per year (kg/y)	Annual Effective Dose (Sv)
1-Iraqi Amoxicillin	0.23	0.3g	0.438 kg	$0.14x10^{-10}$
2-English Amoxicillin	0.72	0.6g	0.876 kg	$0.88x10^{-10}$
3-UAE Amoxicillin	0.55	0.5g	0.73 kg	$0.56x10^{-10}$
4-Indian Amoxicillin	0.52	0.5g	0.5 kg	$0.53x10^{-10}$
5-Iraqi *Paracetamol*	0.34	0.6g	o.657kg	$0.313x10^{-10}$
6-English *Paracetamol*	0.48	0.7g	0.7665kg	$0.515x10^{-10}$
7-UAE *Paracetamol*	0.83	0.6g	0.657kg	$0.763x10^{-10}$
8-Indian *Paracetamol*	0.61	0.6g	0.657kg	$0.56x10^{-10}$
Average	0.535			$0.53x10^{-10}$

Table 4 presents the specific activity and the annual effective dose for ^{228}Ac. The average value of the specific activity was 0.77 Bq/kg, the maximum value was 0.83 Bq/kg for English amoxicillin and the minimum value was 0.56 Bq/kg for Indian amoxicillin. The average value of the annual effective dose was $2.25\text{x}10^{-10}$ Sv, the maximum value was $3.13\text{x}10^{-10}$ Sv for English amoxicillin and the minimum value was $1.66\text{x}10^{-10}$ Sv for Iraqi Paracetamol.

Table 4: Specific activity, sample mass, in take mass per year and annual effective dose of ^{228}Ac for all samples.

Sample	Specific Activity (Bq/kg)	Sample mass (g)	In take per year (kg/y)	Annual Effective Dose (Sv)
1-Iraqi Amoxicillin	0.97	0.3g	0.438 kg	$1.83x10^{-10}$
2-English Amoxicillin	0.83	0.6g	0.876 kg	$3.13x10^{-10}$
3-UAE Amoxicillin	0.78	0.5g	0.73 kg	$2.45x10^{-10}$
4-Indian Amoxicillin	0.56	0.5g	0.5 kg	$1.75x10^{-10}$
5-Iraqi *Paracetamol*	0.59	0.6g	o.657kg	$1.66x10^{-10}$
6-English *Paracetamol*	0.73	0.7g	0.7665kg	$2.4x10^{-10}$
7-UAE *Paracetamol*	0.78	0.6g	0.657kg	$2.2x10^{-10}$
8-Indian *Paracetamol*	0.92	0.6g	0.657kg	$2.59x10^{-10}$
Average	0.77			$2.25\text{x}10^{-10}$

Table 5 shows the values of specific activity and annual effective dose for ^{137}Cs, the average value of the specific activity was 0.65Bq/kg, the maximum value was 0.93 Bq/kg for Iraqi Paracetamol and Iraqi Amoxicillin and the minimum value was 0.212 Bq/ kg for English Paracetamol. And for annual effective dose one can see that the average value was $0.\ 62\text{x}10^{-8}$ Sv, the maximum value was $0.81\text{x}10^{-8}$ Sv for English Paracetamol and the minimum value was $0.48\text{x}10^{-8}$ Sv for English amoxicillin and Indian amoxicillin.

Table 5: Specific activity, sample mass, intake mass per year and annual effective dose of ^{137}Cs for all samples.

Sample	Specific Activity (Bq/kg)	Sample mass (g)	In take mass per years (kg/y)	Annual effective Dose (Sv)
1-Iraqi Amoxicillin	0.93	0.3g	0.438 kg	$0.53x10^{-8}$
2-English Amoxicillin	0.73	0.6g	0.876 kg	$0.48x10^{-8}$
3-UAE Amoxicillin	0.43	0.5g	0.73 kg	$0.57x10^{-8}$
4-Indian Amoxicillin	0.61	0.5g	0.5 kg	$0.48x10^{-8}$
5-Iraqi *Paracetamol*	0.51	0.6g	o.657kg	$0.79x10^{-8}$
6-English *Paracetamol*	0.93	0.7g	0.7665kg	$0.81x10^{-8}$
7-UAE *Paracetamol*	0.212	0.6g	0.657kg	$0.69x10^{-8}$
8-Indian *Paracetamol*	0.81	0.6g	0.657kg	$0.62x10^{-8}$
average	0.65			$0.62x10^{-10}$

Table 6 shows the sum all the annual effective dose values for all isotopes in each sample. It is found that the sum of the annual effective dose values is so small compared with the allowable values. Therefore, they are not a threat for people health.

Table 6: The annual effective dose values of each isotope and their sum for all samples.

Sample	Annual Effective Dose of ^{40}K (Sv)	Annual Effective Dose of ^{214}Pb (Sv)	Annual Effective Dose of ^{228}Ac (Sv)	Annual Effective Dose of ^{137}Cs (Sv)	Total Effective Dose (Sv)
1-Iraqi Amoxicillin	$7.6x10^{-9}$	$0.14x10^{-10}$	$1.83x10^{-10}$	$0.53x10^{-8}$	$1.3x10^{-8}$
2-English Amoxicillin	$15.21x10^{-9}$	$0.88x10^{-10}$	$3.13x10^{-10}$	$0.48x10^{-8}$	$2.04x10^{-8}$
3-UAE Amoxicillin	$6.33x10^{-9}$	$0.56x10^{-10}$	$2.45x10^{-10}$	$0.57x10^{-8}$	$1.23x10^{-8}$
4-Indian Amoxicillin	$48.8x10^{-9}$	$0.53x10^{-10}$	$1.75x10^{-10}$	$0.48x10^{-8}$	$5.383x10^{-8}$
5-Iraqi *Paracetamol*	$77.7x10^{-9}$	$0.313x10^{-10}$	$1.66x10^{-10}$	$0.79x10^{-8}$	$8.579x10^{-8}$
6-English *Paracetamol*	$26.13x10^{-9}$	$0.515x10^{-10}$	$2.4x10^{-10}$	$0.81x10^{-8}$	$3.452x10^{-8}$
7-UAE *Paracetamol*	$48.88x10^{-9}$	$0.763x10^{-10}$	$2.2x10^{-10}$	$0.69x10^{-8}$	$5.607x10^{-8}$
8-Indian *Paracetamol*	$8.55x10^{-9}$	$0.56x10^{-10}$	$2.59x10^{-10}$	$0.62x10^{-8}$	$1.51x10^{-8}$

Conclusions

The annual effective dose from radioactive nuclides in Amoxicillin and Paracetamol samples are very small if compared with the allowable values, hence, the persons can use these drugs without fear.

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