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Specific Activity and Effective Dose Measurements for Different Potassium Salts Which Used by Iraqi Costumers

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Abstract

The specific activity (S.A.) of Potassium – 40 (^{40}K) and its effective dose for three types of salts; Sodium salt, Liver and sea salts, and Potassium salt, were measured. The results of S.A. for these groups are 41.78, 285.5, and 427.84 Bq/kg respectively, whereas for effective dose are 0.315, 2.130 and 3.195 µSv/y respectively. These results strongly suggested that for persons with forty years old, the intake of Potassium salt must be lower than 2 g per day comparing with naturally intake 3.3 g for good health.

Key words: Potassium – 40, Healthy Salts, Specific Activity, Effective Dose

الخلاصة

لقد تم قياس الفعالية النوعية والجرعة الفعالة لثلاثة انواع من الملح المستخدم والتي هي ملح الصوديوم وملح البحر والكبد (والذي هم من نوع واحد حسب محتوى البوتاسيوم) وملح البوتاسيوم. ان نتائج الفعالية النوعية لهذه المجاميع هو 41.78 و 285.5 و 427.84 بكرل/كغم على التوالي, بينما نتائج الجرعة المؤثرة هي 0.315 و 2.130 و 3.195 مايكرو سيفرت/سنة على التوالي. ان هذه النتائج تقترح وبشدة ان يكون الأخذ اليومي لملح البوتاسيوم بحدود 2 غرام للأشخاص الذين اعمارهم اكبر من اربعين سنة مقارنة مع الأخذ الأعتيادي الذي هو 3.3 غرام يوميا من اجل صحة جيدة.

Introduction

Potassium (*K*) is silver – white metal and soft so that it can be cut by a knife. *K* is an important element in the soil and spreads widely in nature and there in almost all plant and animal tissues [1]. In the earth's crust is the seventh in abundance either in the oceans is considered the sixth element. *K* found in mineral waters and brines and in many of the major types of alloys, especially metal ones. *K* is an essential nutrient in plants as an important aspect of the fertile soil. In the case of reduced its concentration in the soil, one must be used fertilizer (especially triple fertilizers *NPK*) in order to get a good plant growth [1]. In mans, *K* represents an important aspect in the diet and in the growth and maintenance of the body. *K* is necessary in transfer water with normal quantities between the cells throughout the body and its fluids [1].

K plays a key role in the response of nerves to stimulate muscle contraction. It is also essential to maintain the good work on the functions of the cardiovascular, where it plays as the electric key and that a lot of people taking it in the form of capsules or tablets or salt form. People use sodium chloride (*NaCl*) in the eating, but those who suffer from high blood pressure, increases the *NaCl* salt leads to increase their high blood pressure and thus heart attack or stroke may be happened [1]. Therefore, physicians are advised to use potassium chloride (*KCl*) salt, which does not lead to a rise in a high blood pressure. On average, the adult human body contains up to *140* grams of *K*, and this rate varies according to body weight and muscle mass. Mans ingest about *3.3* grams of *K* per day through food, drink and excrete almost the same quantity.

The element of K consists of three isotopes [2]: potassium – 39 (^{39}K), which is the most stable and peer abundance (*93.26%*), potassium – 41 (^{41}K), a stable isotope also represents the second in abundance (*6.73%*), and the third isotope is potassium – 40 (^{40}K), which has very small abundance (*0.0118%*). ^{40}K represents the only one radioactive of the three potassium isotopes, which emit beta particles of maximum energy of *1.33 MeV* with rate *89 %* from total emission, while the other part of the emission is gamma rays with energy *1.46 MeV*. The half-lifetime of ^{40}K is 1260 million years

[2], a relatively long lifetime and therefore, is used by many of the geophysics in the dating calculation of the rocks and even in the estimation of the age of the archaeologies as is the case of the ^{14}C isotope.

K is one of the most reactive metals in nature, and that a number of compounds that have many commercial use [3]. For example, potassium permanganate, the color purple, is used as an antibacterial and germicidal. Potassium iodide is used, which is rapid solubility in water, in photography. It is also used in medicine to treat rheumatism and overactive thyroid glands [4]. Again, as an example, solid white potassium carbonate uses to produce glass and soft soap. With nitrogen and phosphorus, potassium chloride is used throughout the fertilizer industry to produce the important tri fertilizer (*KPN* Fertilizer) which is very important for plant growth. ^{40}K is a naturally occurring radioactive isotope and can lead to health hazards, both internal and external. For external hazards, ^{40}K can emit gamma ray with energy of 1.46 *MeV*; therefore, the exposure could be a source of great concern. Either in the body (internal exposure), and in addition to gamma rays, beta particles, which are 89 % of the total radiations, they have significant health risks. The ionizing radiation (beta or gamma) of ^{40}K could affect the health caused by cell damage and thus the probability of cancer incidence may be increased. The risk of death coefficients due to cancer induced by radioactive isotopes have been calculated for all isotopes, including ^{40}K [5, 6]. The ingestion is the most common type of exposure but has risk coefficients less than inhalation. In addition to this internal exposure, ^{40}K could give external exposure. For example, if we assume that 100,000 people are constantly exposed to a thick layer of soil has ^{40}K concentration of 1 *pCi/g*, then, 4 from these 100,000 people will die from cancer resulting from this exposure.

Material and Methods

Six different potassium salt samples were collected from suppliers, which are available in markets and natural radioactivity for ^{40}K radionuclides have been measured. The natural activity of potassium salt was measured using a γ -ray spectrometer system as described in Ref. [7]. The spectrometer consists of a *NaI(Tl) "1.5 X 1.5"* Massy detector, the Preamplifier, High-Voltage power supply, Amplifier and Multi-Channel-Analyzer (*MCA*). The surrounding of the sample cup was shielded by *3 cm* lead in order to shield from other background γ sources. The schematic view of the experimental setup is shown in Figure 1.

The energy calibration of the detection system was done using radioactive sources of ^{137}Cs and ^{60}Co which emit *662* and *1170, 1333 keV* respectively. After calibration of the detection system, the background and real measurement have been done for *7200 s* duration.

A typical γ -ray spectrum for salt sample is shown in Figure 2 where the peak related to the interested radionuclide of ^{40}K is clearly seen.

The specific activity (S. A.) for ^{40}K from the measured salt samples was calculated using the relation:

$$A\left({}^{Bq}/_{kg}\right) = \frac{N}{\varepsilon.P.M.t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where *N* is the net area of counts of the 1.46 *MeV* of gamma line of the ^{40}K radionuclide which recorded in the detector, ε is the efficiency of the *NaI(Tl)* detector, *P* is the branching ratio of the 1.46 *MeV* γ-decay (*10.7%*), *M* is the mass of the sample (*kg*) and t is the counting time in seconds.

On the other hand, the annual committed effective dose (E_k in $Sv.y^{-1}$) to the adult members of the population due to the ^{40}K radionuclide, originated from the ingestion of potassium salt is given by [8]

$$E_K = I_K . e(g)_K \ldots\ldots\ldots\ldots..(2)$$

where I_K represents the annual intake in $Bq.y^{-1}$ for ^{40}K and $e(g)_K$ is the ingestion dose coefficient of ^{40}K which have the value; 6.2×10^{-9} Sv/Bq [8, 9].

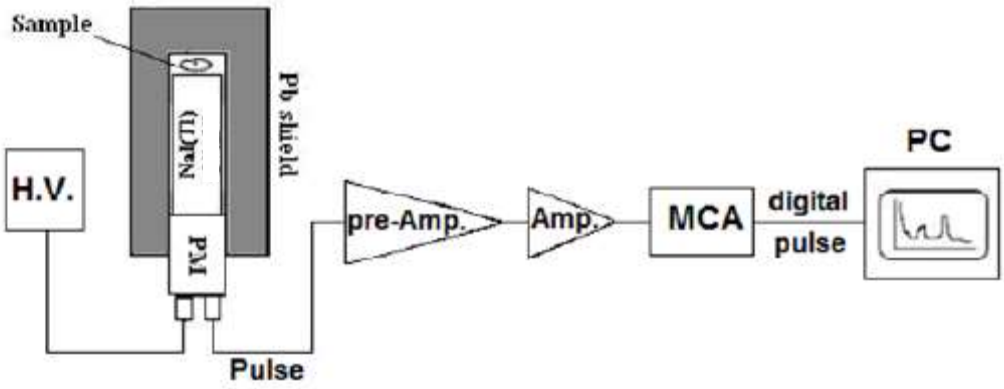

Figure (1): *the Typical Gamma Spectroscopy with NaI(Tl) Detector*

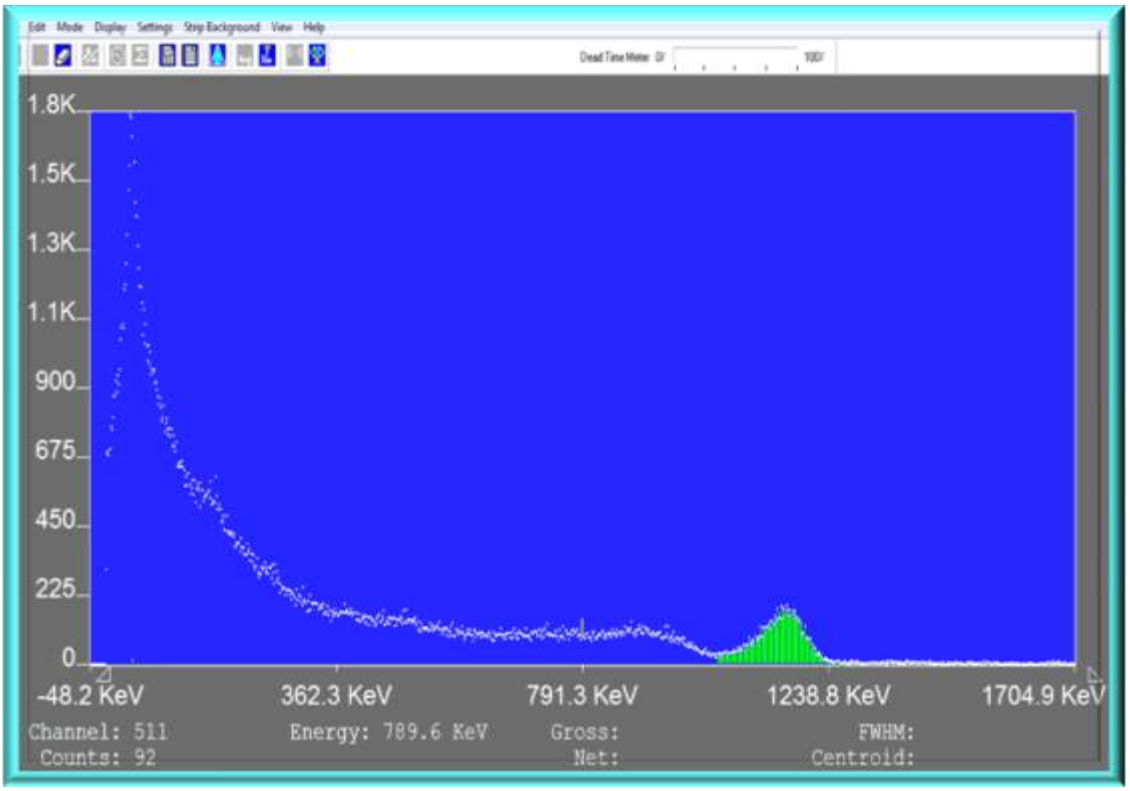

Figure (2): a typical γ -ray spectrum for salt sample

Results and Discussion

Potassium salt is used instead of Sodium salt to control diastolic and systolic of the cardiac if the costumer favorable salty toast in foods [5, 7]. Therefore, one must be chose potassium salt with small radioactivity as possible as we can.

The specific activity and the effective dose for the measured salt samples are shown in table (1) with the origin and companies of its made. The results can be classified into three groups according to the types of salts. The first group is the *Na* salt group, which has natural (small) potassium specific activity with average value about 41.78 *Bq/kgm* and low effective dose about 0.315 *μSv/y*.

The second group is the *sea* and liver *salts*. After examination against the specific activity of potassium, the results shown that this group has median values about 285.5 *Bq/kgm* and there effective dose about 2.13 *μSv/y*.

The third group is the *potassium* salt group. The average specific activity is *427.84 Bq/kgm* and the average effective dose is *3.195 μSv/y*. The Argonne National Laboratory [4] in their report under title "Human Health Fact Sheet" showed that if the effective dose of intake potassium salt about *2.2 μSv/y*, then occurrence probability of cancer increasing rabidly spatially for ages more than *40* years. However, one can be concluding that for persons with age more than *40* years (have noticeable probability of high blood pressure disease), the cancer can be happened with more probability because this ages have weaken cells. In other words, one can noticed that if one intake *5g* per day for *1* year, the probability of cancer increasing rabidly, therefore, one must take it with law intake as possible as you can.

Table (1): *the S. A. and Effective Dose of the Studied Salts*

Groups	*Type of Salt*	*S.A.(Bq/kg)*	*Average S.A.(Bq/kg)*	*Eff Dose (μSv/y)*	*Average Eff.Dose (μSv/y)*	*Remarks*
1	*Iodized salt (zeer)*	***41.19***	***41.78***	***0.31***	***0.315***	*Na - salt delivered from Al - Zaer company in Torkia*
	Salina	***42.37***		***0.32***		*Na - salt delivered from Salena company in Torkia*
2	*Symbiosal*	***236.45***	***285.5***	***1.77***	***2.130***	*Sea Salt delivered from Symbiosa Company in Republic of Korea*
	IbnSina	***333.85***		***2.49***		*Liver salt, delivered from Ibn - Sena company in IRAQ*
3	*Lo-salt*	***401.02***	***427.84***	***2.99***	***3.195***	*K - salt delvers from Scotland*
	Genser	***454.66***		***3.40***		*K - salt delvers from Irjentena*

Conclusions

Three types of salts were studied and the specific activity and the effective dose of each type were measured. From the results, one can conclude that the potassium salt have high effective dose than others salts, therefore, it is not good to use for persons with more than 40 year age. On the other hand, one can use it but with *2 g* delay intake to slower the effective dose to about 2 *μSv/y* which don't affect the health or don't increases the cancer incidence probability.

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