



ENVIRONMENTAL GAMMA RADIATION MEASUREMENT OF FOOD SALT IN SOUTHERN PROVINCES OF IRAQ

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Abstract:

The current manuscript includes measuring the natural dose of emitted gamma-rays for the table salt (nature salt) taken from different locations, in the southern provinces of Iraq. The locations selected are Basrah (Fao (Al-maamir), Hamdan industrial area, and university (Germat-Ali), Al-Nassiriya (Suq Al-Shuyookh), Al-semawa (Sawa Lake) and Al-Amara (Qalat Salih). After using two types of standard quality dosimeters lithium fluoride and Calcium fluoride which are made by Harshaw chemical company and after a series of tests conducted on them to make sure of their validity, it is found that the natural dose rate of gamma-rays in these locations is equal to 8.02, 8.25, 8.2, 7.65, 7.45 and 7.27 $\mu\text{rad/h}$ respectively. The results also show that the natural dose rate of gamma-rays falls within the allowed limit which is 0.5 rem/year as far as the technique used and referred to above is concerned. This study technique is especially interesting because of its low cost, short response times. Furthermore, dosimetric material may be used for personnel dosimetry.

Keywords: Thermoluminescence; Calcium fluoride; lithium fluoride; Pre-irradiation; post-irradiation; Thermal fading.

1. Introduction

Radiation is very important to monitor, when certain phosphorus material was heated after exposures to an ionizing radiation (such as beta-particles, alpha-particles [1-3], gamma-rays [4-8], ect.) The stored energy has been released as visible light in addition to the normal thermal radiation. Re-heating again is directly produced only to the normal thermal emission. The difference between the amount of light in the two cases, i.e , the light emitted from the first

heating minus the thermal emission is called thermoluminescence [9]. This phenomenon was observed firstly during the seventeenth century by Sir Robert Boyle when he reported that a diamond, when heated by the warmth of his hands, emitted light which, although very faint, could be noticed by the naked eye in the dark. From the beginning of 1895 the thermal release used for discovering and measuring the radiation dose, the first application of TL to dosimetry (TLD) were made by Daniels and his co-workers and in early 1950, when LiF used to measure radiation. Since 1965 the use of TLD has increased rapidly because of the advantages of the technique and the availability of commercial phosphors and instrumentation, in recent years many application of TLD have been reported in the medical field, agriculture, age measurement and radiation production [10]. When the depleted Uranium was used to bombard the Iraqi armies and civilian sites in the south of the country, bombardment accidents were responsible for a considerable amount of radiation. It is estimated that more than 300-400 tons of depleted Uranium were left according to American –British reference [11].

In 1989 Nadir Habubi studied the level of radiation in Basrah city by using thermoluminescence, he found that the radiation level was 8.9 $\mu\text{rad/h}$, this value was within the normal-level [12]. In 1990 Abdul Kareem Zweid demonstrated that the Radiation level is about 9.182 $\mu\text{rad/h}$ in building material [13]. In 2006 Master A. Ali measured the environmental radiation of water in the south of Iraq, and he found it uncontaminated [14].

In this research we discuss measuring the radiation level in Iraqi food salt as a resaved form in a different locations in the south of Iraq (Basra, Amara, Nassiriya and samawa).

2. Experimental device and methods

A series of experiments are carried out using two sets of TLDs, one including lithium fluoride (LiF) dosimeters and the other calcium fluoride (CaF_2) dosimeters, each containing 20 dosimeters.

2.1. Pre-irradiation annealing

Pre-irradiation annealing process is used to remove any previous irradiation from the TLDs. The major purpose of this thermal processing is to carry back the traps-recombination centers levels to the previous one achieved after the initialization process [15]. The pre-irradiation annealing of TLDs is carried out using a high temperature thermal processing at 400°C during 1 hour followed by a low temperature thermal processing for 2 hours at 100°C [16,17]. Moreover, the annealing treatment improves the sensitivity of a dosimeter [18]. The samples are prepared in the form of powder. They are ground very soft and carefully using

porcelain mortar. Then the powder is passed through two sieving nets, with sizes 63 and 45 mm. The sodium chloride crystal (NaCl) samples are perfectly milled to be reduced to fine particles by grinding in a mill have been irradiated with gamma rays from a ^{137}Cs gamma source.

2.2. Post-Irradiation Annealing

Post-irradiation annealing process is used to disposal of the glow peaks that fade at room temperature (the low temperature peaks) [19]. This process is made by putting TLDs in an oven at $100\text{ }^{\circ}\text{C}$ for 20 minutes directly after irradiation. The potency of the ^{137}Cs low-dose source was 3.7×10^{10} Bq in 1985 and the potency of the high- radiation dose from ^{137}Cs nuclear source was 44.4×10^{10} Bq in 1982.

2.3. Condition of Measuring

The TLD reading is recorded by the thermoluminescence reader at a heating rate of $5\text{ }^{\circ}\text{C}/\text{sec}$ and to $300\text{ }^{\circ}\text{C}$ for the TLD of LiF and to $320\text{ }^{\circ}\text{C}$ for the TLD of CaF_2 . Figs. 1 and 2 illustrate the glow curve for both dosimeters. Moreover, the red light is applied in the laboratory in the measuring time to avoid the effect of ordinary light one the measurement process.

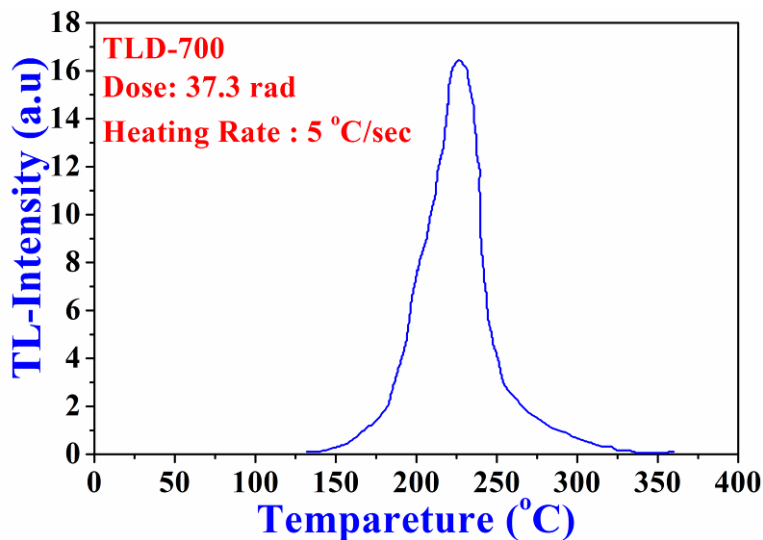


Figure 1: Glow curve for Lithium fluoride with 37.3 rad and post-irradiation annealing $100\text{ }^{\circ}\text{C}/20\text{ min}$.

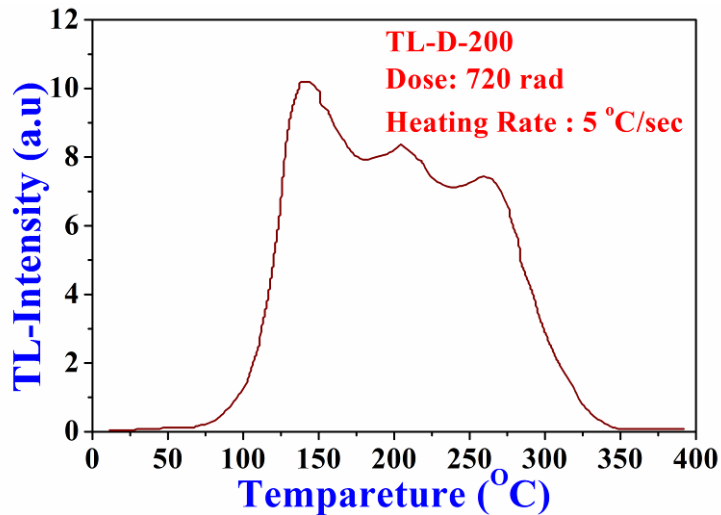


Figure 2: Glow curve for calcium fluoride with 37.3 rad and post-irradiation annealing 100 C/20 min.

2.4. Calibration curve

Annealed TLDs of LiF are irradiated to various doses (6 mrad -78 mrad) of C_S-137 gamma source. After achieving this process of all dosimeters, post-irradiation annealing is done and then measurement stage is began in the thermoluminescence apparatus. In the same way, TLDs of CaF₂ of different doses are irradiated to the same gamma source (6 mrad -117 mrad). Once, irradiation is completed, post irradiation annealing is required. Then, the measurement of TLDs of CaF₂ is made in the thermoluminescence reader apparatus. The findings of this experiment are shown in figs.3 and 4.

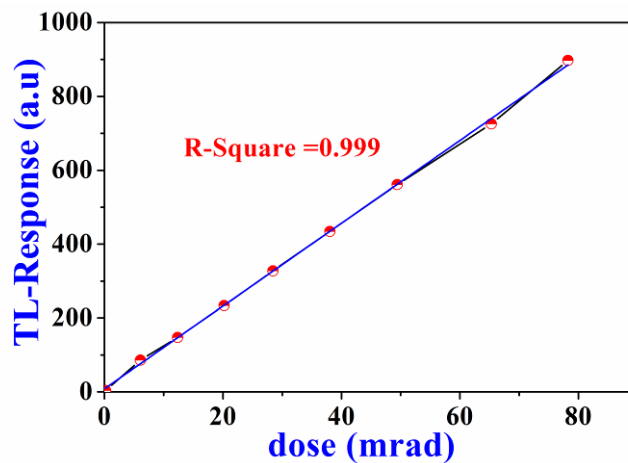


Figure 3: Calibration curve of Lithium fluoride dosimeters.

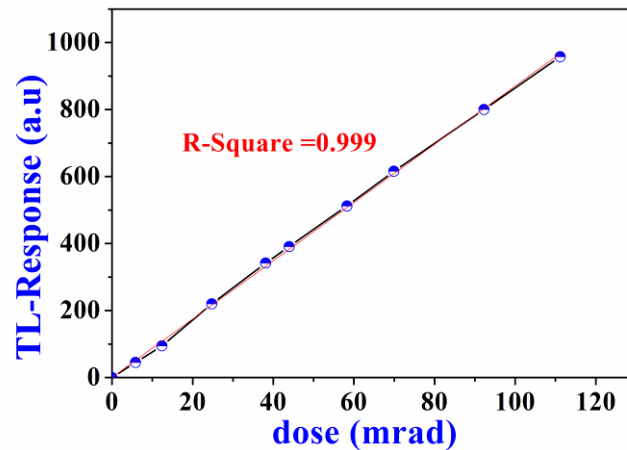


Figure 4: Calibration curve of calcium fluoride dosimeters.

3. Thermal Fading

In order to measure the irradiation doses of the salt samples, dosimeters are put inside plastic containers and attached to the middle of the studied sample. The temperature of these dosimeters corresponds to that of the room where the sample is stored. This condition causes the thermal luminescence signal to be lost (faded), that is why; the thermal fading of thermoluminescence dosimeters is needed be measured by taking a batch of LiF and another of CaF_2 . After pre-annealing process is achieved to them, these TLDs are given a stable dose of 480 mrad. After that, post-irradiation annealing process is performed. Then the TLD batch of LiF and another of CaF_2 are read. The remaining samples are kept in the room where salt samples under study are stored in order to measure their thermoluminescence at various serial times. The thermal fading rate of both of LiF TLD and CaF_2 TLD equals (3%,4%) respectively for two weeks, and this corresponds experimentally with the consequences obtained by the researchers [20,21]. This can be seen in figure 5 and figure 6.

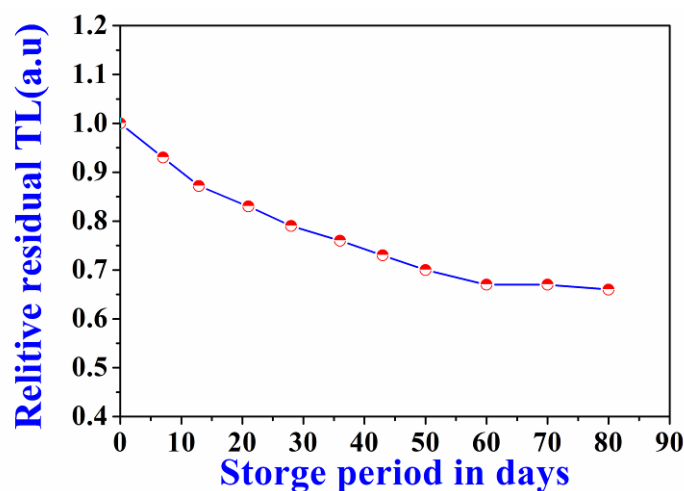


Figure 5: Experimental Thermal fading data of Lithium fluoride at temperature 25 °C

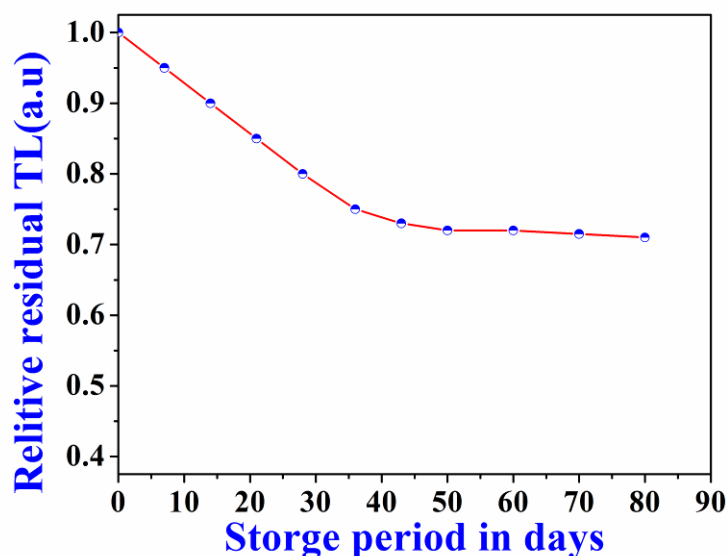


Figure 6: Experimental Thermal fading data of calcium fluoride at temperature 25 °C

4. Result and discussion

After using two types of standard quality dosimeters which are made by Harshaw chemical company and after a series of tests conducted on them to make sure of their validity, it is found that the natural dose rate of gamma rays in these locations is equal to 8.02, 8.25, 8.2, 7.65, 7.45 and 7.27 $\mu\text{rad/h}$ respectively. The results of the average radiation emitted from salt samples are shown in the table 1, each according to its location. The results also show that the natural dose rate of gamma-rays falls within the allowed limit which is 0.5 rem/year as far as the technique used and referred to above is concerned.

Table 1: Dose rate of gamma ray for different locations.

Container No	Dosimeter No	Location	Equivalent Gamma Dose rate $\mu\text{rad/h}$
1	1,2,3	Hamdan Industry	8.25
2	4,5,6	-	
3	7,8,9	-	
4	10, 11, 12	Al-Maamir	8.02
5	13, 14, 15	-	
6	16, 17, 18	-	
7	19, 20, 21	Nassiriya	7.65
8	22, 23, 24	-	
9	25, 26, 27	Semawa	7.45
10	28, 29, 30	-	
11	31, 32, 33	Amara	7.27
12	34, 35, 36	-	
13	37,38,39,40	University of Basrah	8.20

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قياس إشعاع كاما البيئي لمالح الطعام في محافظات جنوب العراق عبد الكريم زويد

الخلاصه:

يتضمن البحث الحالي قياس الجرعة الطبيعية لأشعة كاما المنبعثة من ملح الطعام المأخوذ من مواقع مختلفة ، في المحافظات الجنوبية للعراق. المواقع المختارة هي البصرة (الفاو (المعمير) ومنطقة حمدان الصناعية والجامعة (جرمت علي) والناصرية (سوق الشيوخ) والسماوة (بحيرة سوا) والعمارة (قلعة صالح). بعد استخدام نوعين من مقاييس الجرعات ذات الجودة القياسية ، فلوريد الليثيوم وفلوريد الكالسيوم والتي تصنعها شركة Harshaw الكيميائية وبعد سلسلة من الاختبارات التي أجريت عليهم للتأكد من صحتها ، تم العثور على معدل الجرعة الطبيعية لأشعة كاما في هذه المواقع تساوي 8.02 و 8.25 و 8.2 و 7.65 و 7.45 و 7.27 ميكروغرام / ساعة على التوالي ، كما أظهرت النتائج أن معدل الجرعة الطبيعية لأشعة كاما يقع ضمن الحد المسموح به وهو 0.5 ريم / سنة بالنسبة للتقنية المستخدمة والمشار إليها أعلاه المعنية. تعتبر تقنية الدراسة هذه مثيرة للاهتمام بشكل خاص بسبب تكلفتها المنخفضة وأوقات الاستجابة القصيرة. علاوة على ذلك ، يمكن استخدام مادة قياس الجرعات في قياس جرعات الأفراد.