Journal of medical & pharmaceutical Sciences (JMPS) • Vol 7, Issue 1 (2023) • P: 9 - 1
https://journals.ajsrp.com/index.php/jmps
ISSN: 2522-333X(Online) • ISSN: 2522-333X (Print)

Environmental Radiation Dosimetry for school buildings, hospitals and health centers in Babil Governorate-Iraq using TL-technique

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Received:
03/01/2023

Revised:
12/01/2023

Accepted:
25/01/2023

Published:
30/03/2023

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Citation: Al-Salihi, A., Abul-Hail, R. CH., & Badran, H. A. (2023). Environmental Radiation Dosimetry for school buildings, hospitals and health centers in Babil Governorate-Iraq using TL-technique. *Journal of medical and pharmaceutical sciences, 7(1),*1 – 9. https://doi.org/10.26389/AJSRP.A030123

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Abstract: The current research aims to evaluate the dose rate of gamma rays emitted from school buildings, hospitals and health centers in several locations in Babil Governorate using the TL method. To achieve the objectives of the research, measurements were taken at 49 school building sites and 29 hospital and health center sites using the thermal luminescence technique. The results of this study indicate that the inhabited areas within the environmental monitoring stations are places where the radiation is normal and the average dose rate in school buildings, hospitals and health centers to which humans are exposed is within the permissible limit.

Keywords: Gamma Rays, Radiation Dosimetry, Thermoluminescence Technique

قياس الجرعات الإشعاعية البيئية للمباني المدرسية والمستشفيات والمراكز الصحية في محافظة بابل - العراق باستخدام تقنية التالق الحراري

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المستخلص: يهدف البحث الحالي الى تقييم معدل جرعة أشعة جاما المنبعثة من المباني المدرسية والمستشفيات والمراكز الصحية في عدة مواقع في محافظة بابل باستخدام طريقة TL . ولتحقيق اهداف البحث تم أخذ القياسات في 49 موقع بناء مدرسة و 29 موقع مستشفى ومركز صحي باستخدام تقنية التالق الحراري ، وكانت مشكلة البحث المقارنه بين معدل الجرعة الطبيعية لأشعة جاما في المواقع المختارة وتبين انها تساوي 6.25 rad / h و 6.119 rad / h لـ المباني المدرسية والمستشفيات والمراكز الصحية على التوالي. تشير النتائج في هذه الدراسة إلى أن المناطق المأهولة داخل محطات الرصد البيئي هي أماكن يكون فيها الإشعاع طبيعيًا، ومتوسط معدل الجرعة في المباني المدرسية والمستشفيات والمراكز الصحية التي يتعرض لها الإنسان ضمن الحد المسموح به.

الكلمات المفتاحية: أشعة جاما، قياس الجرعات الإشعاعية، تقنية التألق الحراري

Introduction

The thermoluminescence dosimeter is a useful method for determining ionizing radiation dosage. When the TL material is subjected to radiation, it absorbs the energy and stores it until it is heated. The TL glow curve shows the intensity of emitted light as a function of temperature. Most TL dosimeters respond linearly to dosages up to a few Grays (Azorín Nieto, 2004; Furetta, 2010). Physically, TL dosimeters are tiny. They are suitable for several medical applications (Akkurt, Gunoglu, & Arda, 2014; Al-Salihi, Salim, Alfahed, & Badran, 2020; Azorín Nieto, 2004). Environmental background radiation must be precisely assessed to identify exposures related to the emission of radioactivity from the nuclear site; the amount of environmental radiation must be evaluated to appropriately quantify population exposure. Many researchers have studied this subject to better understand the environmental radiation contamination in soil, water, air, salt, and food to safeguard the environment from the hazards of radiation exposure to people (Abualhail, Abbas, & Alsalihi, 2017; Alfahed, Imran, Majeed, & Badran, 2020; Alsalihi & Abualhiall, 2019; Bdran, Abul-Hail, & Obeed, 2020; Hail & Talib, 2020; Mollah, Husain, & Rahman, 1986; Rejah, Oraibi, & Al-Salihi, 2020; Salman, Al-Ahmad, Badran, & Emshary, 2015). The current study was conducted out in several areas of Babil Governorate, employing TL-dosimetry to conduct a radiation survey of 10 locations. Governorate Center, Al Emam, Al Mashrooa, Al-Qasim, Al Talee'a, Al Hashimiyah, Al Kifl, Al Nile, Al Showmali, Al Midhatiya, are the locations chosen.

In this paper it has included calculated the dos rate of emitted gamma-ray from school buildings, hospitals and health centers taken from different locations in Babil Governorate by using TL-technique.

Materials and Methods

The thermoluminescence dosimeter is more favorable than other approaches for detecting low radiation doses. This is because thermoluminescence dosimeters are tiny and inexpensive, need little field effort, are measured in a laboratory setting, and have acceptable sensitivity, accuracy, and reliability under harsh environmental conditions. Because of their higher degree of accuracy sensitivity, (TLD-200) chips were used for this work (Al-Salihi, Abul-Hail, Badran, & Alfahed, 2022; Alfahed et al., 2020; Alhiall & Alsalihi, 2019; Hassan, Abul-Hail, Badran, & Al-Salihi, 2022). A factory-produced metering container containing 20 dosimeters per batch was used for the calibration and determination of the TL response per m rad(Kellerer, Hahn, & Rossi, 1992). A full batch of dosimeters was annealed for 1 h at 400 degrees Celsius, followed by 2 h at 100 ^{0}C (Al-Salihi et al., 2021; Alfahed et al., 2019; Bdran et al., 2020; Bujdosó, 1987; Ramadhan, Al-Salihi, & Khalaf, 2020). This treatment also improves the dosimeter's sensitivity. The three annealed TLD chips are contained in an opaque plastic container in each environmental dosimeter. For three months, the TLD is permanently stationed at various places under monitoring. The period of this research was from August 2022 to October 2022). There are 78 TLD monitoring stations spread out across100 kilometers, covering all of the province's major districts. A TLD reader (HARSHAW FIL TROL 2000-B/C) with a steady nitrogen flow rate (100 to 500 mL/min) was used to read out all TLD chips. To

decrease fading, the chips were post-annealed for 10 min at 100°C just before reading. Chips were pre- and post-annealed according to established techniques (Harley, 1972). TLD from the same batch was irradiated at the thermoluminescence laboratory at the Department of Physics, College of Education for Pure Science, University of Basrah, using a ^{137}Cs gamma ray source manufactured by company J.L. Shepherd and Associates in California. Where the dose supplied by this source was approximately equal to (20 mrad/min) in 1985 AD and it decreased to approximately (8.362 mrad/min) in 2022 AD where t1/2 = 30.07 y. The 78 sampling stations are located in ten zones. All zones comprise two to five stations in school buildings, hospitals and health centers.

Results and Discussions

The average environmental gamma-ray radiation rate for school buildings, hospitals and health centers AL-Diwaniyah Governorate was studied and measured using thermoluminescence technology. For this objective, 78 environmental stations were set up and implemented. Three months of monitoring were carried out. Table 1 and 2 summarize the result of average dose rates measured using TLD-200 chips for three months in the Babil Governorate (school buildings, hospitals and health).

Table 1: Dose rate of emitted gamma rays from school buildings

Zone	Station	TL (a. u)	Dose rate (µrad/h)	Average (µrad/h)
Governorate Center (Hillah)	G1	16.7	5.62	6.56
	G2	18.43	6.41	
	G3	23.33	7.95	
	G4	20.55	6.88	
	G5	19.56	6.54	
	G6	18.66	6.24	
	G7	18.74	6.17	
	G8	21.13	7.20	
	G9	18.55	6.28	
	G10	18.24	6.15	
Afak Al Emam	A1	23.26	7.76	6.36
	A2	23.46	7.54	
	A3	17.33	5.55	
	A4	13.52	4.54	
	A5	17.63	5.92	
	A6	19.17	6.39	
AL- Hamza Al Mashrooa	H1	18.67	6.23	5.82
	H2	17.24	5.73	
	H3	18.01	5.58	
	H4	17.22	5.61	
AL-Sudair Al-Qasim	Su1	15.43	5.01	5.13
	Su2	15.75	5.24	

Zone	Station	TL (a. u)	Dose rate (µrad/h)	Average (µrad/h)
AL-Shafeieh Al Showmali	Sh1	21.67	7.08	6.77
	Sh2	22.66	7.46	
	Sh3	19.88	6.63	
	Sh4	21.55	6.87	
	Sh5	16.29	5.63	
	Sh6	18.96	6.32	
AL-Sunnih Al Kifl	S1	18.75	6.17	6.29
	S2	20.95	6.98	
	S3	18.48	6.16	
	S4	18.48	6.27	
ALBedair Al Nile	B1	24.16	8.06	6.89
	B2	22.89	7.64	
	B3	18.82	6.58	
	B4	18.72	6.64	
	B5	18.83	6.26	
Sumer Al Hashimiyah	S1	20.44	6.87	6.36
	S2	20.49	7.14	
	S3	17.33	6.37	
	S4	17.75	6.48	
	S5	15.88	5.23	
Never Al Midhatiya	N1	19.32	6.57	6.22
	N2	21.64	6.87	
	N3	16.26	5.40	
	N4	17.85	5.98	
Al-Daghara Al Talee'a	D1	18.76	6.23	6.18
	D2	19.25	5.68	
	D3	19.54	6.57	
		Maximum=24.16 Minimum=13.52 Mean=19.1057	Maximum=8.06 Minimum=4.54 Mean=6.344	Maximum=6.89 Minimum=5.13 Mean=6.25

Table1 shows that the mean average environmental gamma-ray dose is from 4.54 µrad/h to 8.06 µrad/h with an average dose rate is 6.334µad/h in the school building. The minimum value obtained for sample code A4 (Al Emam) and the maximum for sample code B1 (Al Nile). The high value was recorded as, 8.06 µ rad/h.

Table 2: Dose rate of emitted gamma-rays from hospitals and health centers

Zone	Station	TL(a.u)	Dose rate (µrad/h)	Average (µrad/h)
Governorate Center	G1	15.73	5.23	5.62
	G2	14.51	4.77	
	G3	15.8	5.23	

Zone	Station	TL(a.u)	Dose rate (μrad/h)	Average (μrad/h)
	G4	15.8	5.32	
	G5	17.93	5.66	
	G6	19.3	6.26	
	G7	19.24	6.24	
	G8	17.1	5.58	
AfakAl Emam	A1	17.24	5.42	5.65
	A2	17.63	5.86	
AL- Hamza Al Mashrooa	H1	19.04	6.35	5.65
	H2	16.1	5.33	
	H3	15.88	5.29	
AL-SudairAl-Qasim	Su1	18.24	6.13	6.45
	Su2	20.24	6.76	
AL-Shafeieh Al Showmali	Sh1	20.77	6.92	7.22
	Sh2	23.83	7.98	
AL-Sunnih Al Kifl	S1	17.5	6.27	6.46
	S2	18.9	6.27	
	S3	18.55	6.15	
	S4	17.35	5.99	
ALBedair Al Nile	B1	16.16	5.37	5.48
	B2	16.14	5.38	
Sumer Al Hashimiyah	S1	17.2	6.072	6.43
	S2	20.32	6.77	
	S3	20.03	6.65	
	S4	18.62	6.22	
Al-Daghara Al Talee'a	D1	18.86	6.29	6.172
	D2	18.13	6.05	
		Maximum=23.83 Minimum=14.51 Mean=18.0043	Maximum=7.98 Minimum=4.77 Mean=5.992	Maximum=7.22 Minimum=5.48 Mean=6.119

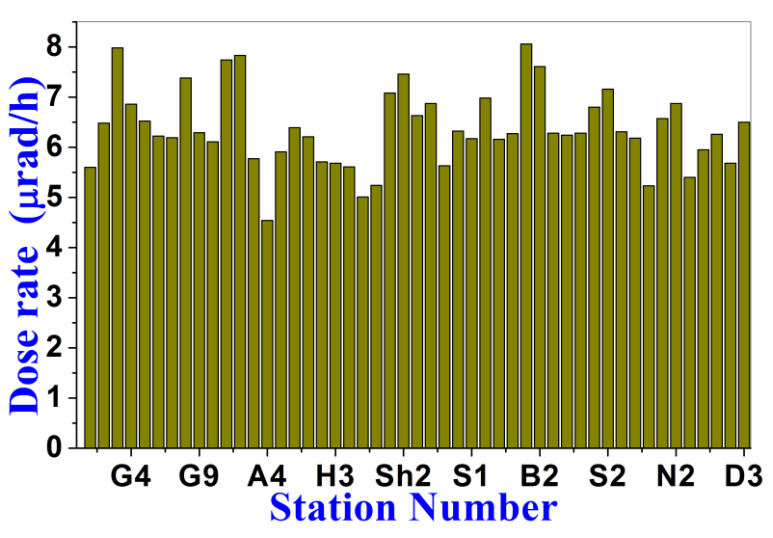

Figure 1: The dose rate of emitted gamma rays from different stations from school buildings.

From figure 1 it can be seen that monthly values do not show any definite pattern, although a slight random variation in the period time three month was observed in school buildings stations, Also as can be seen in Table 2, the mean average environmental gamma-ray dose is quoted at 4.77 µrad/h up to 7.98 µrad/h with an average dose rate of 6.119µad/h in hospital, and health centers. The minimum value was obtained for sample code G2 (Governorate Center) and a maximum for sample code Sh2 (AL-Shafeih). The high value was recorded as, 7.98 µ rad/h.

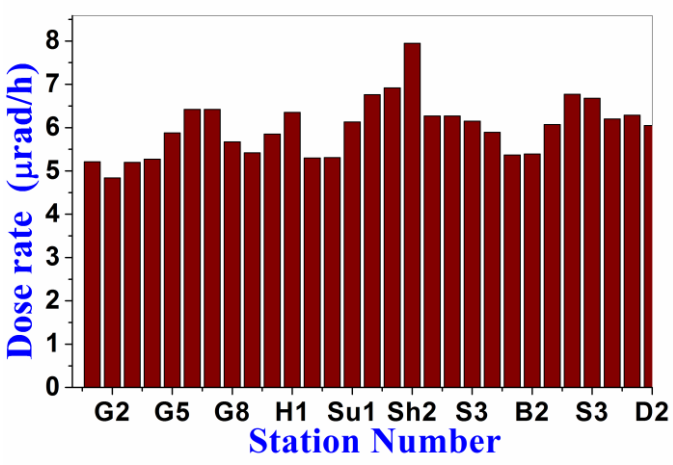

Figure 2: The dose rate of emitted gamma rays from different stations from hospitals and health centers.

From figure 2, it can be seen that monthly values do not show any definite pattern, although a slight random variation in the period time three months was observed. This variation in measured dose values for different stations in Babil Governorate (school buildings, hospitals, and health) may be due to different in the building material used and the presence of laboratory equipment and presence of medical devices and radiology equipment and medicines and medical supplies at different sites as well as variability inherent in the placement of the dosimeter, and the preparation and calibration of the dosimeters (Burke, 1975). The results proved that the inhabited fields lying within the environmental monitoring states are the areas in which the radiation is natural and the rate that the human being

exposed equals (1-20) mSv/y which is considered a natural exposure limit (OBEED & BADRAN, 2020; Protection, 2007). The contribution of radiation doses to the effect on the thermoluminescence signal from the regions listed in the tables 1 and 2, are shown in Figure 3 and Figure 4, respectively. It appears that some areas have high absorbed radiation doses, which have a direct effect on the thermal thermoluminescence signal.

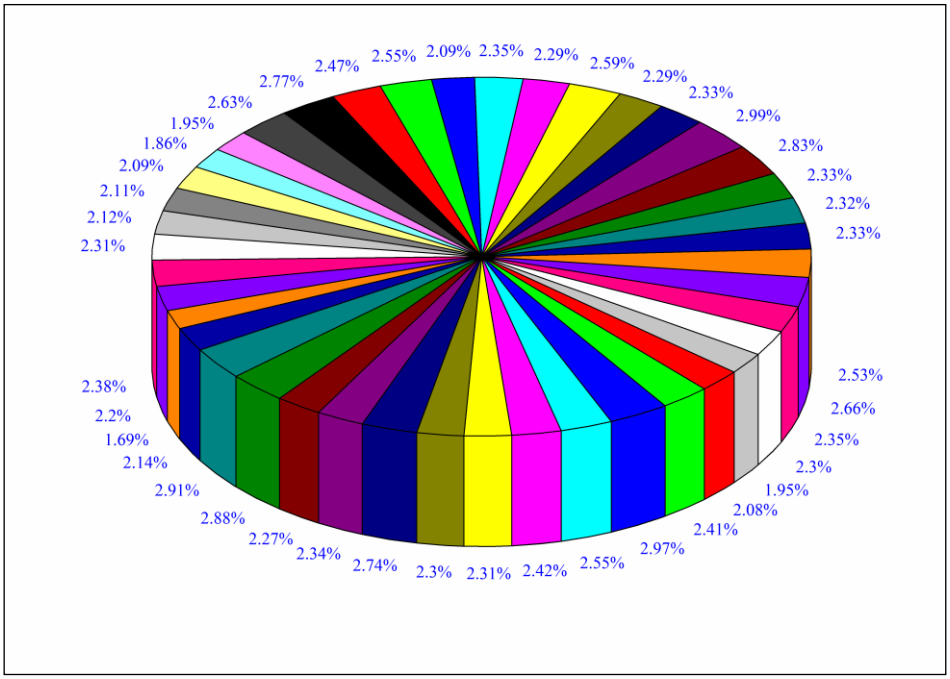

Figure 3: A plot of a dose rate as a function of TLsignal for regions illustrated in table 1 .

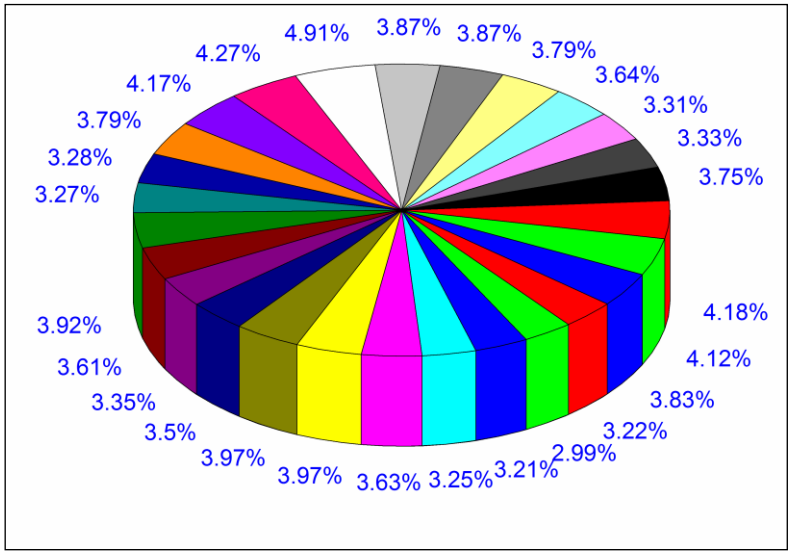

Figure 4: A plot of a dose rate as a function of TL signal for regions illustrated in table 2.

These results are in line with those of previous researchers, and they can be attributed to building materials' inherently radioactive constituents (Al-Salihi et al., 2022; Alhiall & Alsalihi, 2019; El-Taher, 2012; Hassan et al., 2022; Imani et al., 2021; Lewicka, Piotrowska, Łukaszek-Chmielewska, & Drzymała, 2022).

Conclusion

The gamma dose rates emitted from school buildings, hospitals, and health centers in several locations in Babil Governorate were examined. The outcomes have shown that locations referred to in Babil Governorate are safe from any radiation risk. The present study recommends that other locations have similar surveys in order to create baseline data for all locations in Babil Governorate, including school buildings, hospitals, and health centers, for preparing a radiological map of Babil Governorate.

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