Natural Alpha Emitters in Some Types of Medical of Parenteral Solutions (Domestic and Imported) Samples in Iraqi Hospitals

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Abstract

In this research, alpha emitters (^{222}Rn, ^{226}Ra and ^{238}U) were measured by solid state nuclear track detector (LR-115 type 2 detector) in some types of medical of parenteral solutions samples that commonly used in Iraqi hospitals. The results show that the average values of the concentrations for ^{222}Rn (in air space and inside sample), ^{226}Ra, and ^{238}U in samples of the present study were 52.62±9.01 Bq/m3, 0.26±0.04 Bq/L, 0.246±0.04 Bq/L, and 0.232±0.039 ppm, respectively. The average value of alpha emitters was within the acceptable world limitations. Therefore, it may conclude that there is no danger in medical parenteral solutions samples of the present study on human health.

Key Words: Alpha Emitters, Medical Parenteral Solutions, LR-115 Type 2 Detector, and Iraqi Hospitals.

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Introduction

Nuclides with half -lives comparable with the age of the earth (or decay products, the concentration of which is governed by them) are released from terrestrial materials. In terms of dose ^{232}Th and ^{238}U are the primary radionuclides (Atwood, D.A., 2013). Uranium radionuclides and one thorium decay give rise to radionuclide families which decay in three distinct series. The first starts with the decay of 238U (half-life 4.5×10^{9} y) and is named (uranium series), the second begins with ^{232}Th (half-life 1.4×10^{10} y), which is named (thorium series), and the third begins with ^{235}U (half-life 7.1×10^{8} y), which is named (actinium series). All three series have alpha emitters. Alpha radiation are fairly large, heavy particles (helium nucleus) containing of 2 neutrons and 2 protons, while beta radiation is composed of electrons, which are in particulate form (Röhlsberger, R, 2004). Uranium (^{238}U), Radium (^{226}Ra) and Radon (^{222}Rn) are typical alpha emitters (Abojassim, A.A., 2020). Radon, radium and uranium fall into the same group because they are radionuclides, key elements that are unstable participate considerably in releasing ionizing radiation. Alpha particle is very damaging to human because it have high massive and high charged compared to the other ionizing radiation, where it work on damage the cells encounter it (Washington, C.M., & Leaver, D.T., 2015). The degree of ionization depends on alpha particles energy and length of exposure. The elements that have radioactive properties such as uranium, radon and radium exist in food, water, air and soil. Therefore, the process of inhaling and ingesting of these radionuclides above normal becomes a source of potential health-related hazards (Baxter, M., 2013).

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Hence, the increase in the levels of radionuclides will affect adversely on the human body, and likely participate to elevate hazards of lung cancer development by emitting alpha particles. Medical of parenteral solutions is the feeding of a person intravenously, bypassing the usual process of eating and digestion. The person receives nutritional formulae that contain nutrients such as glucose, salts, amino acids, lipids and added vitamins and dietary minerals (Hellerman Itzhaki, M., & Singer, P., 2020). The main contain of the medical of parenteral solutions (parenteral nutrition) is water. This water may be contain concentration of natural and anthropogenic radioisotopes such as alpha particles, which lead to population exposure for these radioactive. Therefore, the increased exposure or the intake of uranium, radon and radium in medical of parenteral solutions may have negative consequences and implications in the human body (Schloerb, P.R., & Amare, M., 1993). The Overall aim of this study is to measure the alpha particles concentrations in samples of medical of parenteral solutions collected from local hospital in Iraq using Solid-State Nuclear Track Detector (SSNTD) technique.

Methodology of Research

Ten of medical of parenteral solutions samples (Domestic and Imported) were collected from different hospitals of Iraq, that shown in Table (1).

Table 1. Medical of parenteral solutions samples in present study

No.	Type of solutions	Company name	Sample code	Sample type	Original
1	Glucose water	Gulf	N1	Imported	U.A.E
2	Dextrose saline	Kuwait	N2	Imported	Kuwait
3	Dextrose saline(4%)	Pioneer	N3	Domestic	Iraq
4	Ringer –Lactate	Pioneer	N4	Domestic	Iraq
5	Normal saline	EL NASR	N5	Imported	Egypt
6	Dextrose saline (5%)	Pioneer	N6	Domestic	Iraq
7	Dextrose saline (0.9%)	Darou Pakhsh	N7	Imported	Iran
8	Dextrose saline	Darou Pakhsh	N8	Imported	Iran
9	Normal saline	Pioneer	N9	Domestic	Iraq
10	Manntol Injection	EL NASR	N10	Imported	Egypt

After the collection of the medical parenteral solution samples, they were transferred to an advanced nuclear physics laboratory with the code of the sample to measure alpha emitters without any preparation process. A LR-115 Type 2 (SSNTDs) with a thickness of 12um (Bristol, Track Analysis Systems Ltd., UK) detector with area (1×1 cm^2) were used in the present study. A medical parenteral solution sample with a volume equal to (10 ml) was placed in a container that 2.5 cm radius, 7.5 cm higher, and volume about 137 ml. Then, one LR-115 type 2 track detector was placed at the closed top end of a plastic cup (container) at normal room temperature for exposure time of 70 day. After the exposure process, LR-115 type 2 detectors were etched in (2.5 N) of NaOH (sodium hydroxide) at 60 ^{o}C for 1.5 hour. Next, detectors were rinsed in distilled water and recorded tracks using an optical microscope with a magnification of 400X (Hady, H. N., *et al*, 2016).

The track density (ρ) was determined by using the following relation (Abojassim, A. A., 2021):

$$\rho\left(\frac{Track}{cm^2}\right) = \frac{Average\ of\ total\ tracks}{Area\ of\ field\ view} \qquad (1)$$

The radon concentrations in airspace of the tube (C) for medical parenteral solution samples were given by equation (2) (Hashim, A.K., *et al*, 2021):

$$C\left(\frac{Bq}{m^3}\right) = \frac{\rho}{K\,t} \qquad (2)$$

Where, t is exposure time, and k is calibration factor that equal similar to the report in some other place (Eappen, K. P., & Mayya, Y. S., 2004), (Abid, A. A., *et al*, 2017), (Abojassim, A. A., *et al*, 2017).

The radon concentrations in samples under study (C_{Rn}) may be calculated by equation (3), according to many parameters such as radon decay constant (λ), depth of sample in container (h), and the distance between sample to detector (IBRAHIM, A. A., 2014):

$$C_{R_n}\left(\frac{Bq}{m^3}\right) = C\left(\frac{\lambda h t}{L}\right) \qquad (3)$$

Also, according to same parameters such as mass of sample (m), area of surface container (A), the real of exposure time (T_e) which equal in present study is 68 day using equation in previous study [ref], and another parameters, can be calculated the radium content (C_{Ra}) of the samples under study by equation (4) (Abojassim, A. A., & Lawi, D. J., 2018).

$$C_{Ra}(Bq/Kg) = \left(\frac{\rho}{k.Te}\right)\left(\frac{hA}{M}\right) \quad (4)$$

At last, according to W_U, W_s which means weight of uranium in samples under study, and weight of sample, respectively, can be calculated the uranium concentrations (C_U) of the samples under study by equation (5) (Abdulwahid, T. A., *et al*, 2020), (Hassan, A., *et al*, 2019):

$$C_U(ppm) = \frac{W_U}{W_s} \quad (5)$$

Results and Discussion

Table 2 is illustrates the results of C (^{222}Rn concentrations in airspace of the tube), C_{Rn} (^{222}Rn concentrations in samples), C_{Ra} (^{226}Ra content in samples), and C_U (^{238}U concentrations in samples). From Table 1 and Figure 1, the values of C in unit (Bq/m^3) were ranged from 11.43 to 97.14, with an average as well as stander error (S.E) value of 52.62±9.01, while the values of C_{Rn} in unit (Bq/L) were ranged from 0.058 to 0.493, with an average as well as S.E value of 0.26±0.04. Also, From Table 1 and Figure 2, the values of C_{Ra} in unit (Bq/L) were ranged from 0.05 to 0.46, with an average as well as S.E value of 0.25±0.04. But, Also, From Table 2 and Figure 3, the values of C_U in unit (ppm) were ranged from 0.05 to 0.43, with an average as well as S.E value of 0.23±0.039. The findings in Figures 1, 2, and 3 illustrate, the minimum value of C, C_{Rn}, C_{Ra}, and C_U for medical parenteral solution samples in the present study was in N1 sample (Glucose water; Gulf of company that important from U.A.E.), while the maximum value was in N10 sample (Manntol Injection; EL NASR of company that important from Egypt). It is very difficult compare the world limited values of alpha emitters such as ^{222}Rn, ^{226}Ra and ^{238}U in medical of parenteral solutions samples, because don't found or absence the previous studies in samples of present study. Therefore, it can be compared from drinking water which it is main structure or main component for making these parenteral solutions. These results data shown in table 2 indicate that alpha emitters (^{222}Rn, ^{226}Ra and ^{238}U) was nearly differing in all samples, which could be due to the difference in the level of natural radioactivity and geological area in water that contain the original structure of the samples under study. The results of CRn concentration in all samples under study turn out to be within the average acceptable limit as reported in WHO 2008 (0.5Bq/L) (Pfister, A.M., 2000), (WHO, 2008). Also, the results of C_{Ra} were within the global average limitations (1 Bq/l) that recommended by WH0 2011(WHO, 2011). While, the values of C_U were within the global average limitations (0.566 ppm) that recommended by EPA organization (Raymond-Whish, S., 2007). Next, it may be found the medical of parenteral solutions samples under study were low and not significant from a health hazard point of view.

Table 2. Results of C, C_{Rn}, C_{Ra}, and C_U of medical of parenteral solutions samples under study

Sample code	C Bq/m^3	C_{Rn} Bq/L	C_{Ra} Bq/L	C_U ppm
N1	11.43	0.058	0.05	0.05
N2	25.71	0.131	0.12	0.11
N3	34.29	0.174	0.16	0.15
N4	20.57	0.104	0.1	0.09
N5	40	0.203	0.19	0.18
N6	62.86	0.319	0.29	0.28
N7	80	0.406	0.37	0.35
N8	85.71	0.435	0.4	0.38
N9	68.57	0.348	0.32	0.3
N10	97.14	0.493	0.46	0.43
Average ±S.D	52.62±9.01	0.26±0.04	0.25±0.04	0.23±0.039

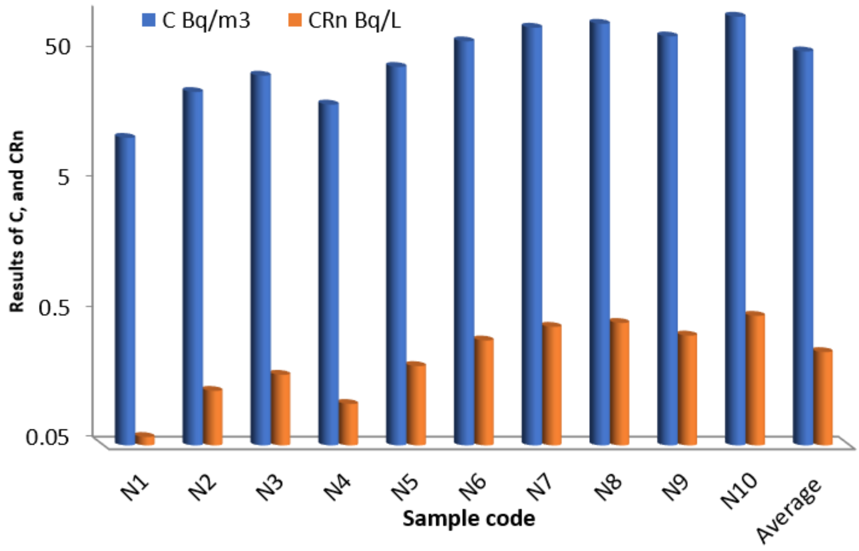

Figure 1. Results of C, C_{Rn} in medical parenteral solution samples of present study

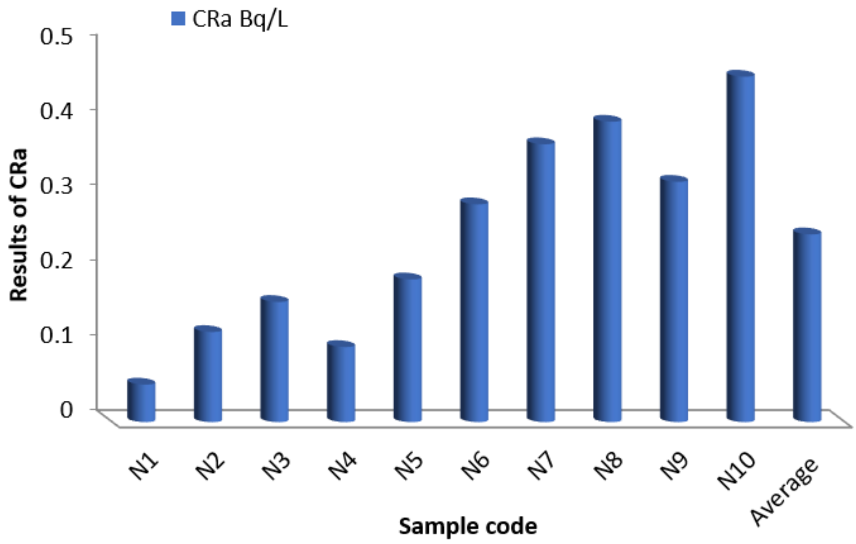

Figure 2. Results of C_{Ra} in medical parenteral solution samples of present study

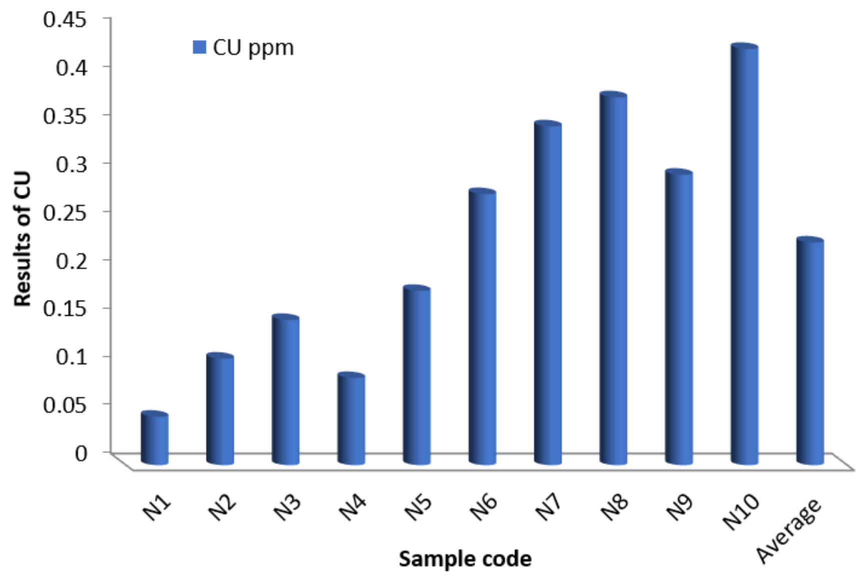

Figure 3. Results of C_U in medical parenteral solution samples of present study.

Conclusions

SSNTD with LR-115 type 2 detector is a good tool for measuring f alpha emitters (^{222}Rn, ^{226}Ra, and ^{238}U) in medical parenteral solution samples that collected from different hospitals of Iraq. The concentrations of ^{222}Rn, ^{226}Ra, and ^{238}U in the present samples are within the global limit. Therefore the sample of domestic and imported of the present study are suitable for human uses according alpha emitters.

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