

The Measurements of Uranium Concentration in Human Blood in Selected Regions in Iraq Using CR-39 Track Detector

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Abstract. The technique of fission track has been applied to determine the concentration of uranium in blood samples for people, male and female of Basrah city (south of Iraq), using CR-39 track detector. During the Gulf Wars I and II in 1991 and 2003 respectively, this city became a place of military operations. The measurements were done for samples of human blood for people to study the impact of exposure in this city as compared to results from Babylon city (central Iraq); the latter is far from exposure locations. The results showed that the uranium concentrations in human blood of people in Basrah city ranged from 0.83 ppb to 2.47 while for people in Babylon city, the uranium concentration ranged from 0.3 ppb to 1.59 ppb. It has also been found that the uranium concentration in human blood samples of people in Basrah city is higher than those of people in Babylon city. Results showed statistically significant differences in the uranium concentration in the residential area.

Introduction

Uranium trace determinations in the blood samples give a fairly good estimate of the quantity of heavy elements within distinct body tissues. Uranium is widespread in nature, being present in a wide variety of solid, liquid, and gaseous compounds. It readily combines with other elements to form uranium oxide, silicates, carbonates, and hydroxides [1]. There are different possible paths by which uranium can reach the human body either in a direct way by inhaling uranium-bearing dust particles or by drinking water which is polluted by uranium, or in an indirect way from the fertile soil layer via the food chain [2]. Solubility of uranium varies depending on the particular compounds and the solvent, and this solubility determines how quickly and efficiently the body absorbs them from the lung and the intestines, respectively [3].

Uranium deposited in the bones and other organs is subsequently released back into the blood stream, which causes several health problems ranging from cancer to kidney failure, respiratory disorders, congenital abnormalities, skin diseases, and other obscure unknown diseases [4,5]. War, as the most extreme form of violence, has the main effect in the exposure of humans to uranium weapons; the first use of uranium weapons was in the Gulf Wars I and II [6]. In the south of Iraq especially in Basrah city, uranium was and still an environmental pollution problem since its levels raised after both Gulf Wars I and II, and the contaminated places haven't been limited or isolated to stop and avoid the spreading of this radioactive contamination [7].

Solid-state nuclear track detectors (SSNTDs) are being used to determine the concentration of uranium in human blood samples. The fission track technique was suggested by Fleischer et al. [8] who proposed the method of using thermal neutron irradiation of solid-state track-recording materials that are in contact with both films and they are pressed together to dry the blood. This technique appears particularly suitable for quantitative determination of uranium in the blood.

The aim of this study is to determine the concentration of uranium in the blood samples for the people in selected regions in Iraq using CR-39 nuclear track detector, and to study the relationship between the age, and the type of human gender.

Experimental method

The experimental technique of uranium concentration in blood samples is the same as reported elsewhere [5, 9]. In this study, 45 blood samples of individual volunteers, male and female, were taken from Basrah and Babylon city. The volunteers had no previous history occupational exposure to (U^{238}). They completed a comprehensive questionnaire about demographic information such as age, gender and medical history.

Blood samples were heated at 37 °C for 24 h using an electric heating incubator to dry and to oxidize organic material. The powders collected in the form of 0.5 g of dried powder blood were mixed with 0.1 g of methylcellulose ($C_6H_{10}O_5$) used as a binder. The mixture was pressed into a pellet of 1 cm diameter and 1.5 mm thickness. The pellets were covered with CR-39 track detector on both sides and were put in a plate of paraffin wax at a distance of 5 cm from Am-Be neutron source as shown in Fig. 1 with a thermal fluence equal to ($3.02 \times 10^9 \text{ n cm}^{-2}$) for 7 days, to cause latent damage to the detector due to ^{235}U (n, f) reaction. After the irradiation, the CR-39 detectors were etched in (NaOH) solution with normality (N= 6.25) at a temperature of 60 °C for 5 h.

The induced fission tracks densities were recorded using Olympus optical microscope with magnification of 400×. The fission track densities were measured on surfaces showing uniform distribution of uranium.

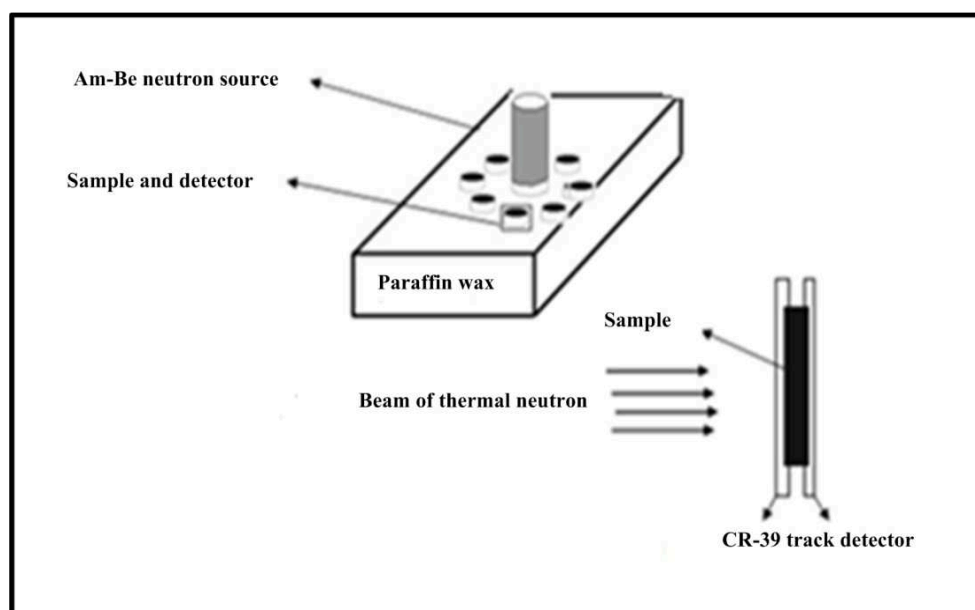


Fig. 1 The irradiation of the samples and detectors to the neutron source

Calculations of uranium concentrations

Uranium concentration in the blood samples was measured by comparison between track densities registered on the detector of blood samples and that of the standard samples by (Eq. 1) [9].

$$C_x = \rho_x \cdot (C_s / \rho_s) \quad (1)$$

Where ρ_x and ρ_s are the induced fission track density for unknown sample and standard sample in (tracks/mm²), C_x and C_s denote the uranium concentration for unknown sample and standard sample in (ppb).

The slope of the linear relation between track density and uranium concentration for standard sample in Fig. 2 is equal to the reciprocal of the second term on the right-hand side of (Eq. 1), the equation becomes

$$C_x = \rho_x / \text{slope} \quad (2)$$

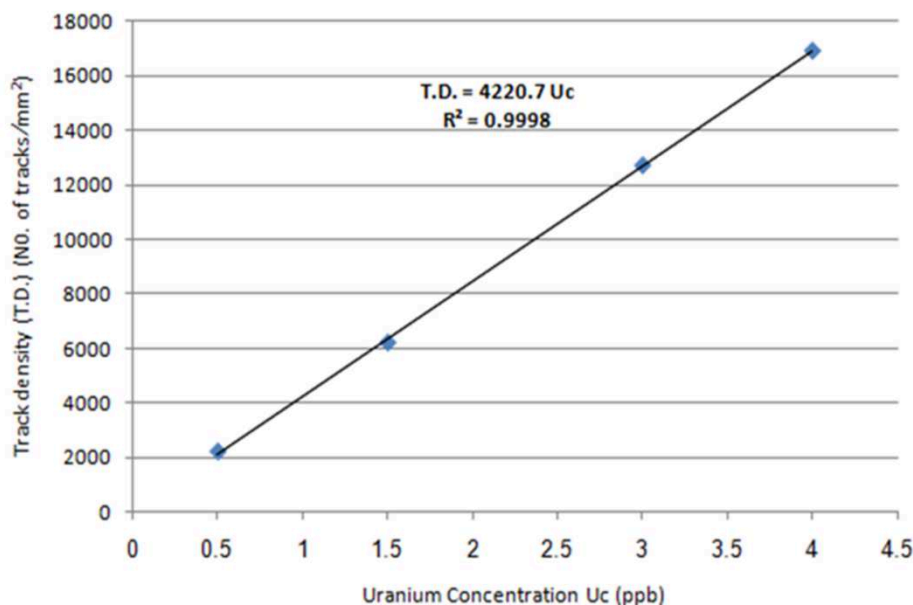


Fig. 2 The relation between track density and uranium concentration in (ppb) for standard samples.

Statistical analysis

The obtained results were statistically processed using Statistical Package of the Social Sciences (SPSS) and the significance of the probability level (P) was estimated by Independent sample T-Test.

Result and discussion

Uranium concentrations in blood samples of individual volunteers in Basrah and Babylon city are summarized in Table 1, from this table the uranium concentration in blood samples of Basrah people ranged from 0.83 ppb to 2.47 ppb, with the average value of uranium concentration was 1.77 ppb, and this finding is higher than reported data of other researchers [5, 9, 10]. The uranium concentration in blood samples of Babylon people ranged from 0.3 ppb to 1.59 ppb, with the average value of uranium concentration was 0.992 ppb. From this table, the average value of uranium concentration in blood samples of people in Basrah city is higher than those of people in Babylon city. Based upon these mean values, about 78 % increase of uranium concentration in blood was observed between people in Basrah and Babylon city. The independent sample T-Test confirmed statistically significant difference in the uranium concentration in blood samples between the people in Basrah and Babylon city ($P < 0.001$). The reason behind such results can be attributed to the fact that the city of Basrah was the center of military activities during the Gulf Wars I and II, and the discarded weapons are still lying around in this region. This indicates that the people living in Basrah city exposed to the uranium levels higher than those living in Babylon city.

Table 2 shows the uranium concentration in blood samples as a function of age group. The average values were found to be proportional to the age group. The average concentration of U in the age 60 years and more was 2.02 ppb and a factor of 1.1 higher than for the age 40-59 years. It also is a factor of 1.2 higher than for the age 20-39 years and about twofold higher than that for the age between 0-19 years. This indicates a significant of uranium concentration with age; such an

increase is also predicted by the ICRP uranium model [11] under conditions of continuous level of intake. Moreover; such an increase with age is expected because dietary intake during childhood is correlated with age.

Fig. 3 illustrates the mean value of uranium concentration in blood samples of male and female in Basrah and Babylon city. The figure shows that the average value of uranium concentration in blood samples of females is larger than that in blood samples of males, because the total blood volume in females is 4-5 L, while that in males is 5-6 L. The Independent sample T- Test showed no statistically significant difference in the uranium concentration with gender ($P > 0.05$)

Table 1 Range and average of uranium concentration (ppb) in blood samples of Basrah and Babylon residents

City	Basrah	Babylon
No. of subjects	30	15
Range	0.83 – 2.47	0.3 – 1.59
Mean $\pm$ Std Error	1.77 ± 0.044	0.992 ± 0.097

Table 2 Uranium concentration in blood samples of Basrah and Babylon residents as a function of age.

Age group (Year)	No. of subjects	Average uranium concentration in (ppb) $\pm$ S.D
0 - 19	14	0.97 ± 0.044
20 - 39	17	1.66 ± 0.049
40 - 59	10	1.8 ± 0.037
60 and more	4	2.02 ± 0.036

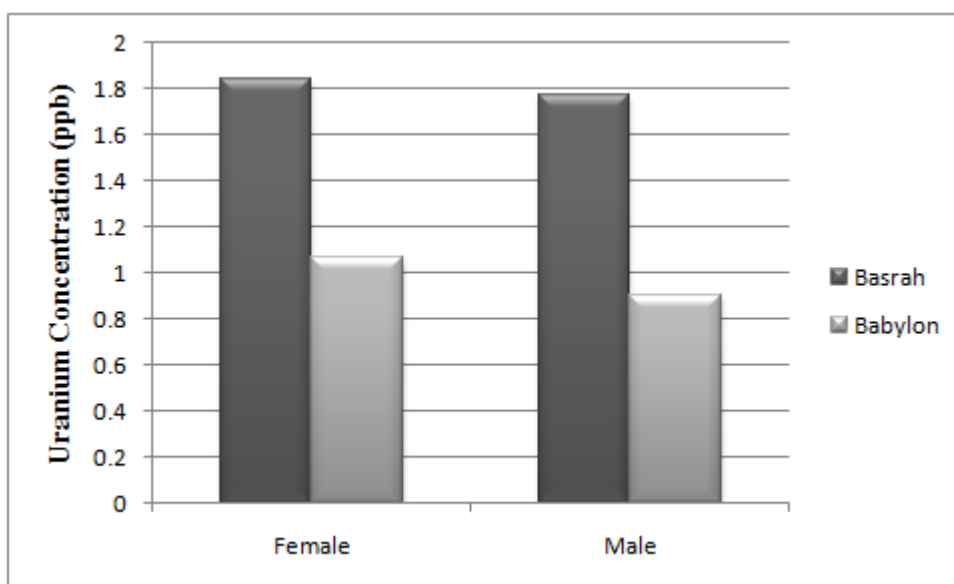


Fig. 3 Uranium concentration in blood samples as a function of gender

Summary

Results obtained show that uranium concentration in human blood samples from Basrah residents is higher than those of Babylon residents. This indicates that the people living in Basrah city exposed to high levels of uranium.

The average values of uranium concentration in blood samples were found to be proportional to the age. This indicates a significant of uranium concentration with age.

Also uranium concentration in blood samples of females is larger than that in blood samples of males.

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