Uranium Concentrations Measurement in Beef And Lamb Samples from Selected Regions in Iraq

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Abstract

Neutron activation technique for solid state nuclear track detectors CR-39 has been applied to determine uranium concentrations in beef and lamb samples collected from selected regions in Iraq. The results show that the uranium concentrations in beef samples ranged between (6.84 – 12.75 μg kg^{-1}), whereas uranium concentrations in lamb samples ranged between (4.70 – 8.37 μg kg^{-1}). The results indicated that the mean value of uranium concentration in beef and lamb samples of the southern Iraq region is higher than those of other locations. The levels of uranium concentrations in animal tissues are normal and lower than limit recommended by ICRP.

Key words: Uranium concentration, Nuclear track detectors, Beef, Lamb

الخلاصة

تم تطبيق تقنية التنشيط النيوتروني لكواشف الاثر النووي في الحالة الصلبة CR-39 لتحديد تراكيز اليورانيوم في نماذج لحوم الأبقار والأغنام التي تم جمعها من مناطق مختارة في العراق. أظهرت النتائج ان تراكيز اليورنيوم في لحوم الابقار تراوحت بين (6.84 – 12.75 μg kg^{-1}) ، في حين تراوحت تراكيز اليورانيوم في لحوم الأغنام بين (4.70 – 8.37 μg kg^{-1}). أشارت النتائج الى ان متوسط قيمة تراكيز اليورانيوم في نماذج لحوم الأبقار والأغنام في منطقة جنوب العراق اعلى من تلك في المناطق الأخرى. مستويات تراكيز اليورانيوم في الأنسجة الحيوانية طبيعية واقل من الحد الموصى به من قبل ICRP .

الكلمات المفتاحية: تركيز اليورانيوم، كواشف الأثر النووي، لحم بقر، لحم غنم

Introduction

Uranium is probably available everywhere in the environment. It is present in the earth’s crust, groundwater, surface, drinking water, food of vegetal and animal origin (Merkel *et al.*, 2002). Due to its radioactivity and heavy metal toxicity which presents a serious threat to the environmental balance and human health, uranium is regarded as one of the most dangerous pollution interests (Al-Hamzawi *et al.*, 2014a; Zou *et al.*, 2011). Uranium might affect humans in different ways, including an internal and external exposure. Internal exposure to uranium happens through the ingestion of polluted water and food or through the inhalation of polluted air. The natural uranium is still the main source of exposure for human beings. There are other activities that may contribute to the presence of uranium in the environment, including uranium mining, milling, leaching from natural deposits, fertilizer production, nuclear energy and nuclear weapon production (ATSDR, 1999; Boice *et al.*, 1996).

Previous studies on the biological and health effects of uranium have found that uranium deposits in the bones and other human organs is subsequently released back into the blood stream, which causes several health problems (Stearns *et al.*, 2005; Miller *et al.*, 2003). Fission track analysis technique (FTA) with CR-39 nuclear track detectors (NTDs) is the effective method to determine the trace concentrations of uranium in biological samples. There are many studies which have been carried out to investigate and determine the concentrations of uranium in different biological samples, including (blood, urine, human and animal tissues) using fission track

technique (Al-Hamzawi *et al.*, 2015; Al-Hamzawi *et al.*, 2014b; Tawfiq *et al.*, 2013; Saleh *et al.*, 2013; Tawfiq *et al.*, 2011).
The paper aims at determining concentrations of uranium in red meat (beef and lamb) collected from different locations of Iraq using CR-39 track detectors. Red Meat is highly nutritious. It is the primary source that supplies the human body with the necessary protein, nutrients and other vitamins such as iron for its growth.

Materials and Methods

In this study, 12 samples of red meat (beef and lamb) were collected from 6 governorates in Iraq, which are Karbala, Babil, Diwaniyah, Dhi-Qar, Muthanna and Basrah as shown in figure (1), where the average age of the cows in this study is higher than the sheep. The experimental technique for the determination of uranium concentration is the same as reported elsewhere (Al-Hamzawi *et al.*, 2015; Tawfiq *et al.*, 2011). FTA with sensitive plastic nuclear track detector (CR-39, Pershore Moulding Ltd, UK) is used to determine the uranium concentration in beef and lamb samples. Each sample was washed with filtered water to separate the contaminants. The samples were dried and then ashed at 250 $^{\circ}$C. The ashed samples were sufficiently milled and stored in plastic vials. The ashed tissues of (0.5 g) were mingled with (0.1 g) of starch which is used as a binder. The mixture was pressed into a pellet which has a dimension of 1 cm diameter and 1.5 mm thickness. Both sides of the pellet had been covered with CR-39 track detector. The pellets were located in a dish of paraffin wax at a distance of 5 cm from (Am–Be) neutron source for 7 days with a thermal flounce equal to (3.024×10^{9} n cm^{-2}) in order to cause latent damage to the CR-39 detector due to ^{235}U (n, f) reaction. The setup of the irradiation the detectors and samples of the neutron source is shown in Fig. 2. After the irradiation process, the CR-39 detectors were etched in NaOH etchant solution under controlled conditions as reported elsewhere (Al-Hamzawi *et al.*, 2015; Al-Hamzawi *et al.*, 2014a). The induced fission track densities were recorded using the optical microscope with magnification of 400 ×. Fission track density was measured via the following equation (Alter and Fleisher, 1981):

$$\text{Track density } (\rho) = \frac{\text{average of totala pits (tracks)}}{\text{area of field view}} \qquad (1)$$

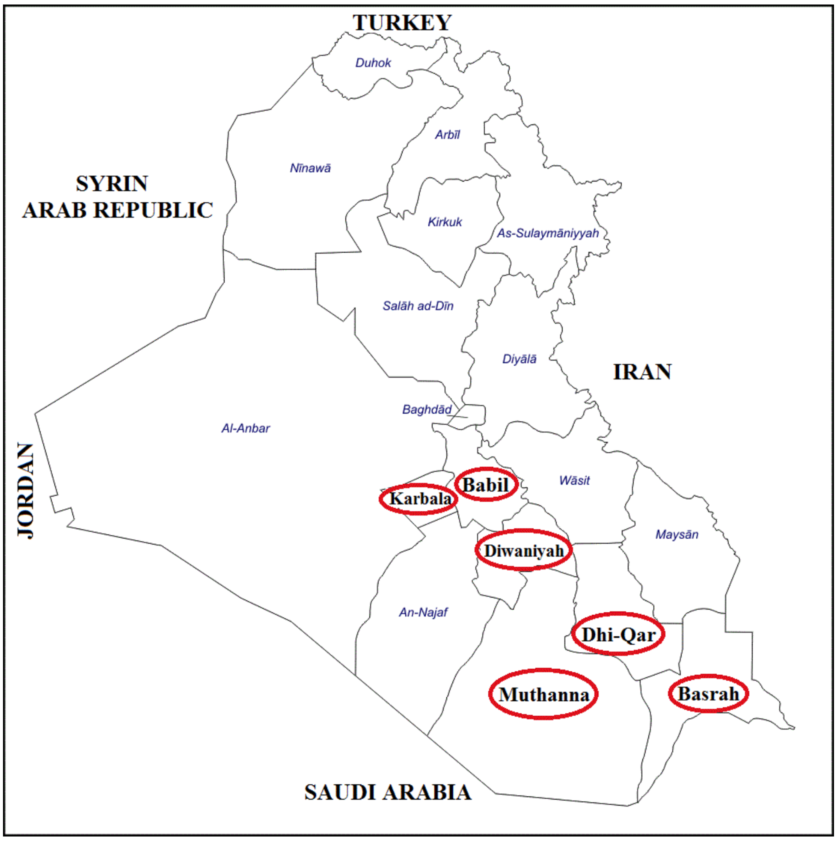

Figure (1): The location of the governorates involved in this study

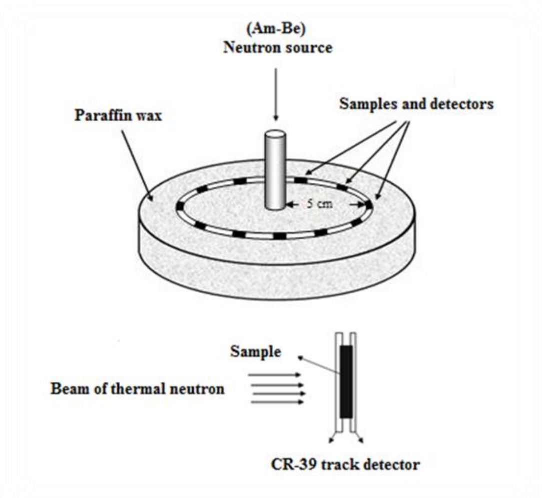

Figure (2): The irradiation of the detectors and sample to the neutron source

Uranium concentrations in beef and lamb samples were carried out by comparing between the densities of track registered on CR-39 detectors around the sample and that of standard samples, via the following equation (Al-Hamzawi et al., 2015; Khan and Qureshi, 1994):

$$\frac{\rho_x}{\rho_s} = \frac{c_x}{c_s} \quad (2)$$

Where ρ_x and ρ_s are the induced fission track density for unknown sample and standard sample in (tracks mm^{-2}), c_x and c_s are the uranium concentration for unknown sample and standard sample in (μg kg^{-1}), the final equation becomes:

$$c_x = \rho_x \times \left(\frac{c_s}{\rho_s}\right) \quad (3)$$

Results and Discussion

The analytical results obtained from the beef samples are involved in this study are shown in Table 1. From this table, the highest value of uranium concentration obtained in beef samples is 12.75 ± 0.32 μg kg^{-1} found in sample T6 from Basrah governorate, whereas the lowest value of uranium concentration obtained is 6.84 ± 0.21 μg kg^{-1} found in sample T2 from Babil governorate. The mean value of uranium concentration in beef samples is 10.14 ± 0.36 μg kg^{-1}.

Table 2 illustrates the uranium concentration in lamb samples. The highest value obtained in lamb samples is 8.37 ± 0.38 μg kg^{-1} found in sample T11 from Muthanna governorate, whereas the lowest value obtained is 4.70 ± 0.18 μg kg^{-1} found in sample T8 from Babil governorate. The mean value of uranium concentration in lamb samples is 6.95 ± 0.31 μg kg^{-1}.

Table (1): Uranium concentration in beef samples

Sample code	location	Uranium concentration in (μg kg^{-1}) ± S.D
T1	Karbala	8.76 ± 0.46
T2	Babil	6.84 ± 0.21
T3	Diwaniyah	9.69 ± 0.32
T4	Dhi-Qar	10.89 ± 0.44
T5	Muthanna	11.91 ± 0.33
T6	Basrah	12.75 ± 0.32
Mean ± Std Error		**10.14 ± 0.36**

Table (2): Uranium concentration in lamb samples

Sample code	location	Uranium concentration in (μg kg^{-1}) ± S.D
T7	Karbala	6.12 ± 0.19
T8	Babil	4.70 ± 0.18
T9	Diwaniyah	6.78 ± 0.28
T10	Dhi-Qar	7.53 ± 0.43
T11	Muthanna	8.37 ± 0.38
T12	Basrah	8.19 ± 0.41
Mean ± Std Error		**6.95 ± 0.31**

Table 3 shows the mean value of uranium content in beef and lamb as a function of location. From this table, the mean value of uranium concentration in beef and lamb samples of the southern Iraqi governorate is 11.85 ± 0.36 μg kg^{-1} and 8.03 ± 0.40 μg kg^{-1} respectively, while the mean value of uranium concentration in beef and lamb samples of central Iraqi governorates is 8.43 ± 0.33 μg kg^{-1} and 5.86 ± 0.22 μg kg^{-1}, respectively. It is obvious that the mean value of uranium concentration in beef and lamb samples of southern Iraqi governorates (Basrah, Muthanna and Dhi-Qar) is higher than those in central Iraqi governorates (Karbala, Babil and Diwaniyah). The high concentrations of uranium values in samples from southern Iraqi governorates, can be explained as being due to the ingestion of the uranium contaminated pasture grass due to the radiological contamination of soil as a result of military activities during the Gulf Wars (Al-Hamzawi *et al.*, 2015; Fathi *et al.*, 2013; IAEA, 2010). Where southern Iraq is agricultural region, so the nutrition of the animal depends essentially on the vegetable and grass. Therefore, the uranium concentration will be increasing in vegetation of animal. However, Southern Iraqi regions are considered as dry areas with the dusty climate at most of the time of the year, even in the rainy season in Iraq. Therefore, air is also regarded as a health hazard, and dust particles containing Naturally Occurring Radioactive Materials (NORM) also act as a contamination source of the organisms.

Table (3): Mean value of uranium concentration (μg kg^{-1}) in beef and lamb samples as a function of location

	Location	Mean ± Std Error
Beef	southern Iraq	11.85 ± 0.36
	central Iraq	8.43 ± 0.33
Lamb	southern Iraq	8.03 ± 0.40
	central Iraq	5.86 ± 0.22

As can be seen in Figure 3, the average value of uranium concentration in beef samples is 1.46 times higher than the average value of uranium concentration in lamb samples. The reason can be attributed to the fact that the age of cows is higher than sheep where there are many studies indicated that the uranium content is correlated with the age of the living organisms (ICRP, 1995a; ICRP, 1995b). The results indicate that the levels of uranium concentration in biological tissues for the animals which are normal and lower than limit recommended (1.5 mg kg^{-1}) by ICRP (Tawfiq *et al.*, 2011).

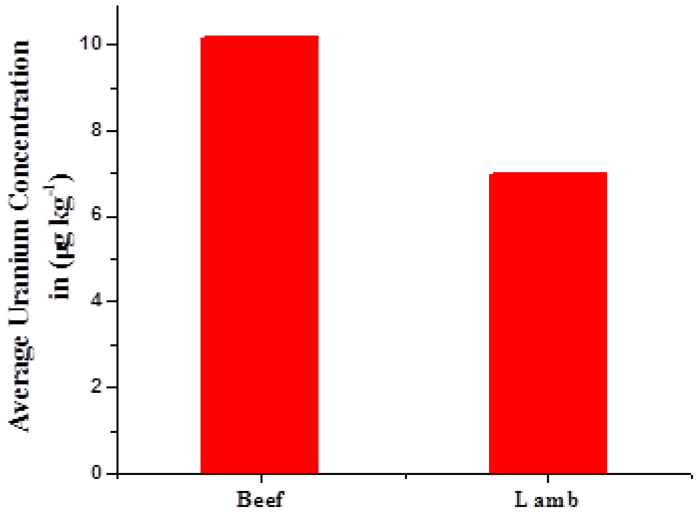

Figure (3): Average uranium concentration in beef and lamb samples

Conclusion

From the results, it is found that the uranium concentration in beef samples is higher than the uranium concentration in lamb samples. The mean value of uranium concentration in beef and lamb samples of southern Iraqi governorates is higher than those in central Iraqi governorates. The recorded values were found to be within the acceptable limits recommended by ICRP.

References

Al-Hamzawi, A. A., Jaafar, M. S., & Tawfiq, N. F. (2014a). Uranium concentration in blood samples of Southern Iraqi leukemia patients using CR-39 track detector. Journal of radioanalytical and nuclear chemistry, 299(3), 1267-1272.

Al-Hamzawi, A. A., Jaafar, M. S., & Tawfiq, N. F. (2014b). The measurements of uranium concentration in human blood in selected regions in Iraq Using CR-39 track detector. In Advanced Materials Research, (925), 679-683.

Al-Hamzawi, A. A., Jaafar, M. S., & Tawfiq, N. F. (2015). Concentration of uranium in human cancerous tissues of Southern Iraqi patients using fission track analysis. Journal of Radioanalytical and Nuclear Chemistry, 303(3), 1703-1709.

Alter, W. H., Fleisher, R. L. (1981). Passive integrating radon monitor for environmental monitoring. Health Phys, 40(5):639–702.

ATSDR, Agency for Toxic Substances and Disease Registry, (1999). Toxicological profile for uranium. US Department of Health and Human Services, Atlanta, USA, 1-448.

Boice Jr, J. D., Land, C. E., & Preston, D. L. (1996). Ionizing radiation. Cancer epidemiology and prevention. Oxford University Press, New York.

Fathi, R. A., Matti, L. Y., Al-Salih, H. S., & Godbold, D. (2013). Environmental pollution by depleted uranium in Iraq with special reference to Mosul and possible effects on cancer and birth defect rates. Medicine, Conflict and Survival, 29(1), 7-25.

IAEA, International Atomic Energy Agency, (2010). Radiological conditions in selected area of southern Iraq with residues of depleted uranium, Report by An international Group of Experts, Vienna, Austria.

ICRP, International Commission on Radiological Protection, (1995a). Age Dependent Doses to Members of the Public form Intake of Radionuclides: Part 4 Inhalation Dose Coefficients. ICRP Publication 71, Pergamon Press, Oxford, UK.

ICRP, International Commission on Radiological Protection, (1995b). Age Dependent Doses to Members of the Public form Intake of Radionuclides: Part 3 Ingestion Dose Coefficients. ICRP Publication 69, Pergamon Press, Oxford, UK.

Khan, H. A., Qureshi, A. A. (1994) Solid state nuclear detection: a useful geological/geophysical tool. Nucl Geophys, 8(1):1–37.

Merkel, B., Planer-Friedrich, B., & Wolkersdorfer, C. (2002). Uranium in the aquatic environment. Springer-Verlag, Berlin.

Miller, A. C., Brooks, K., Stewart, M., Anderson, B., Shi, L., McClain, D., & Page, N. (2003). Genomic instability in human osteoblast cells after exposure to depleted uranium: delayed lethality and micronuclei formation. Journal of Environmental Radioactivity, 64(2), 247-259.

Saleh, A. F., Elias, M. M., & Tawfiq, N. F. (2013). Determination of uranium concentration in urine of workers in an Iraqi phosphate mine and fertilizer plants. Journal of Radioanalytical and Nuclear Chemistry, 298(1), 187-193.

Stearns, D. M., Yazzie, M., Bradley, A. S., Coryell, V. H., Shelley, J. T., Ashby, A., Asplund, C. S., & Lantz, R. C. (2005). Uranyl acetate induces hprt mutations and uranium–DNA adducts in Chinese hamster ovary EM9 cells. Mutagenesis, 20(6), 417-423.

Tawfiq, N. F., Ali, L. T., & Al-Jobouri, H. A. (2013). Uranium concentration measurements in human blood for some governorates in Iraq using CR-39 track detector. Journal of Radioanalytical and Nuclear Chemistry, 295(1), 671-674.

Tawfiq, N. F., Yas, R. M., Alrawi, N. B., & Elias, M. M. (2011). Determination of uranium concentration in sheep organs for some Iraqiś cities. J. Baghdad Science, 8(3), 766-770.

Zou, W., Bai, H., Zhao, L., Li, K., & Han, R. (2011). Characterization and properties of zeolite as adsorbent for removal of uranium (VI) from solution in fixed bed column. Journal of Radioanalytical and Nuclear Chemistry, 288(3), 779-788.