Determination of Uranium Concentration in Sheep Organs for Some Iraqi's Cities

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Abstract:

The aim of this research is to determine the uranium concentration and its distribution in many sheep organs that live in different region of Iraq. The uranium concentration in tissue samples is measured by using fission tracks registration in CR-39 detector that caused by the bombardment of U^{235} with thermal neutrons from (^{241}Am-Be) neutron source of thermal flux ($5x\ 10^3$ $n.cm^{-2}.\ s^{-1}$). The results show that the maximum uranium concentration in bronchiole tissues of the animals was found in Karbala city (3.706ppm) while the minimum concentration (0.127 ppm) was found in Al-Faluja city, also the same result in lung tissue the maximum value was found in Karbala city (2.313ppm) and the minimum concentration in Al Fluja (0.082). Otherwise, the maximum concentration in liver tissue was found in AdDiwaniyah city (1.156ppm) while the minimum concentration in Al Fluja city (0.153ppm). The uranium concentrations in heart tissues were found various than the previous results. The results of average uranium concentration in each animal were ranged from 0.149 to 1.675 ppm, the maximum values were found in the cities in south region of Iraq.

Key Words: uranium concentration, nuclear track detectors, biological tissues, liver.

Introduction:

All uranium isotopes are primarily alpha particle (α) emitters. These alpha particles will travel only about 30μm in soft tissue and, therefore, are unable to penetrate paper, glass, or even the dead superficial layer of skin.

Beta particles (β) have greater ability to penetrate the skin. In most circumstances, beta particles are only present a hazard if internalized. In contrast, gamma rays are extremely penetrating. As such, gamma rays (γ) present a hazard both internally and externally [1]. The hazard of ionizing radiation is derived from the energy, it transfers to matter including biological matter, through which it travels. This energy is dissipated in living tissues by diverse molecular interactions including DNA (genetic material) that may cause in genetic damage [2].

Depleted uranium (DU)has the same three isotopes of natural uranium but in a different isotopic ratio from natural uranium. The danger of depleted uranium particulate and its radioactive daughter products such as thorium -234, protactinium -234, and other isotopes of uranium itself is that they will continue to emit ionizing radiation (α ,β and γ) for decades to come . DU can enter the body in the form of uranium metal from fragments and as uranium oxides from oxidized DU formed after impact on hard targets. The major uranium oxides generated are U_3O_8, UO_2 and UO_3[3].

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These three uranium oxides are relatively insoluble, dissolving only slowly in body fluids. Uranium is absorbed into the blood, carried and retained in body tissues and organs. Once absorbed, uranium forms soluble complexes with bicarbonate, citrate, or proteins [4]. The fraction of uranium absorbed into the blood is generally greater following inhalation than following ingestion of the same chemical form. The fraction will also depend on the particle size distribution. For some soluble forms, more than 20% of the inhaled material could be absorbed into blood. The uranium that is absorbed into the blood, approximately 70% will be filtered by the kidneys and exerted in the urine within 24 hours; this amount increases to 90% within a few days. Because a major portion of uranium circulating in blood is exerted in urine, increased urinary uranium excretion can provide a sensitive quantitative measure of exposure, especially acute exposure. The remaining uranium is not excreted mostly distributes to bone and soft tissues, including the kidney, liver, lung, fat, muscle, and then, to some extent, to all other organs [5,6].

Solid state nuclear track detectors (SSNTDs) are used for measuring concentration and spatial distribution of isotopes if they emit heavy charge particles, either directly or as a result of specific nuclear reactions[7]. The damage caused by these particles along their path is called track (latent track), may become visible under an ordinary optical microscope after etching with suitable chemicals [8]. The latent track can be observed after using a chemical etchant analysis, which makes to analyze the damage regions, where the damage regions have a high activity and effectiveness (in comparison with undamaged regions). The shape of the etched track depends on the charge, velocity of the incident particle, concentration and temperature of the etchant solution, in addition to the environmental circumstances.

There are many studies which have been performed to investigate and measure the concentrations of uranium in biological samples (tissues, bone, blood, etc.) by using the solid state nuclear track detectors [9-11].

CR-39 is organic detector which is used in this work. The chemical composition for this material is ($C_{12}H_{18}O_7$) and has density ($1.32 g.cm^{-3}$). The use of the CR-39 plastic as a nuclear particle detector has become generalized in the field of dosimetry, spectroscopy and environmental science due to its high sensitivity [12].

The detector sheets of 500μm thick were cut into small pieces each of 1cm×1cm area.

The irradiation source consists of a rod of (Am – Be) surrounded by a paraffin wax, which is used to moderate the fast neutrons to thermal neutrons energies. (Am – Be) neutron source which is used for irradiation the tissue samples with thermal flux 5×10^3 $n/cm^2.s$. It emits fast neutrons from the (α, n) reaction such as:

$$Be + \alpha \rightarrow {}^{12}C + {}_0{}^1n + 5.67MeV \text{ -----(1)}$$

Materials and Methods:

Tissue samples were taken from sheep organs that have been living in different Iraqi cities, these cities are specified by numbers as in Table (1):

Table (1): The selected locations

Number of location	City
1	Tikrit
2	Fluja
3	Karbala
4	Al Kut
5	Ad Diwania
6	An Nasria
7	Maysan

The organs were dried gradually, and then incinerated at 450° c . The resultant ash samples were mixed with methylcellulose (C_6 H_{10} O_5) as a ratio of (0.5: 0.1 gm) which was used as a binder. The mixture was pressed into a pellet of 1 cm diameter and 1.5 mm thickness. these were put in contact with (CR – 39) detector in a plate of paraffin wax at a distance of (5 cm) from the neutron source as shown in Fig.(1), with flounce of thermal neutron (3.024×10^9 n.cm^{-2}) [13].

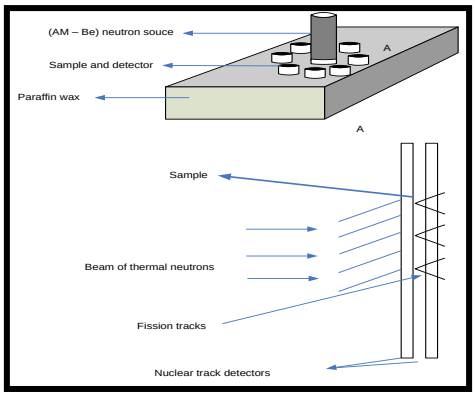

Fig. (1): The irradiation of detectors and samples to the neutron Source [14]

After irradiation for 7days , (CR – 39) detectors were etched in (N=6.25) NaOH solution at temperature of 60°C for (7hr) then washed by distilled water and dried. The induced fission tracks densities were recorded using optical microscope.

The density of the fission tracks (ρ) in the samples has been calculated according to the following relation:

Track density (ρ) = average number of total pits (tracks) / area of field view

The Uranium concentrations in the tissue samples have been measured by comparison between track densities registed on the detectors of the unknown samples and that of the standard samples according to [15]:

C_x(sample)/ρ_x(sample)=C_s(standard)/ρ_s (standard)

$C_x = C_s .(\rho_s/ \rho_x)$

C_x: Uranium concentration in unknown sample (ppm).

C_s: Uranium concentration in standard sample (ppm).

ρ_x: track density of unknown sample (tracks/mm^2).

ρ_s: track density of standard sample (tracks/mm^2).

C_s (standard)/ ρ_s (standard) deduced from the calibration curve shown in Fig.(2)

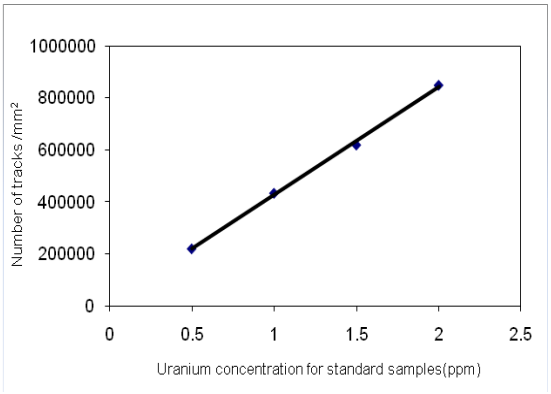

Fig.(2) : Track density versus uranium concentration in standard samples

Results and Discussion:

Table (2) presents uranium concentrations of irradiated tissue samples for sheep organs as measured by the (CR – 39) detector.

Table (2): Uranium concentrations (ppm) of different organs from a single sheep for different Iraqi cities.

organ	Uranium concentration in different organs in study regions (ppm) number of location						
	1	2	3	4	5	6	7
bronchiole	0.243	0.127	3.706	0.184	0.534	0.256	0.498
lung	0.154	0.082	2.313	0.253	0.354	0.186	0.278
heart	0.112	0.232	0.388	0.364	0.306	0.129	0.437
liver	0.189	0.153	0.296	0.267	1.156	0.229	0.346
average concentration in each animal	0.175	0.149	1.675	0.267	0.506	0.200	0.39

Fig.(3-a) shows that the uranium concentration in bronchiole samples for different cities has the highest value (3.706ppm) in location (3) and the lowest value (0.127ppm) in location (2).

Fig. (3-b) shows the uranium concentrations in lung samples which shows the highest value (2.313ppm) in location (3) and the lowest value (0.082ppm) in location (2). The high concentrations of uranium values can be explained as being due to the ingestion of the depleted uranium contaminated pasture grass due to the contamination of soil. The highest concentration in Karbalaa city because of the uranium concentration in its soil is considered relatively high, and this city 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.

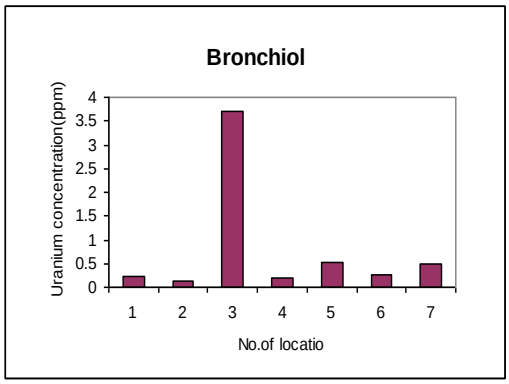

Fig. (3-a)

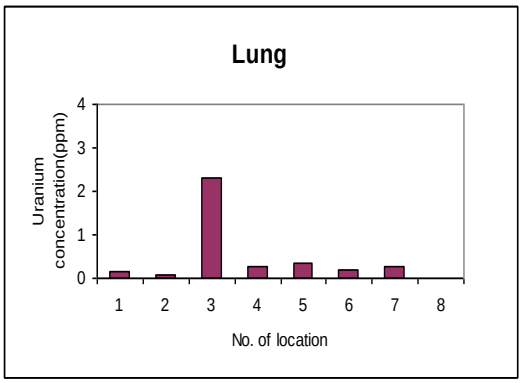

Fig.(3-b)

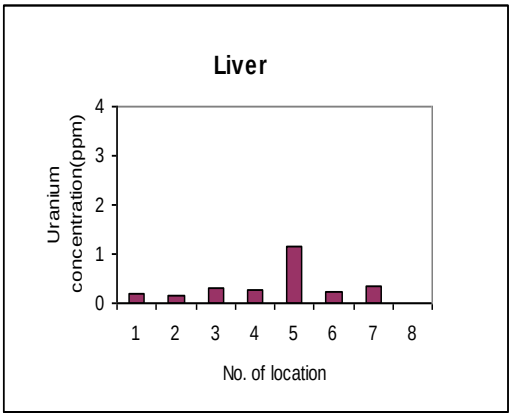

Fig. (3-c)

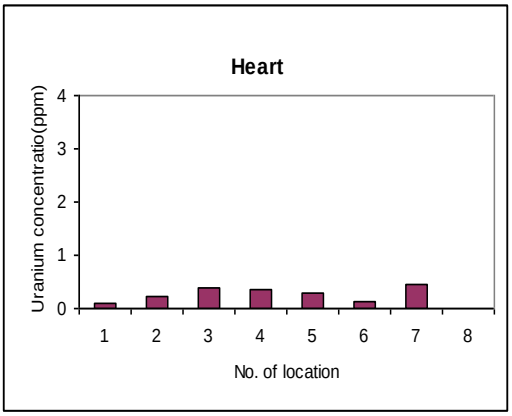

Fig. (3-d)

Figs.3 (a,b,c,d) :The uranium concentrations in various organs in (ppm)

The average uranium concentrations in each animal were ranged from (0.149 to 1.675 ppm), as shown in Fig. (4). This shows the maximum concentration is (1.675ppm) in Karbalaa city and minimum concentration is (0.149) in Al - Fluja city. It is obvious that the highest concentrations of uranium in the southern cities of Iraq where a lot of military operations, using DU weapons have taken place [16,17]. The results indicate that the occurrence of elevated levels of uranium concentration in some biological tissues for the animals which is normal and lower than limit recommended (1.5) by ICRP, unless the bronchiole and lung tissues in Karbalaa city record values above this limit [11].

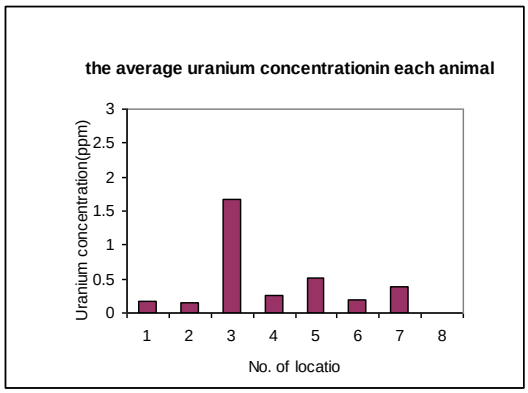

Fig.(4): Average uranium concentration in the samples for each animal of different cities in Iraq.

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تحديد تركيز اليورانيوم في أعضاء الاغنام لبعض المدن العراقية

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الخلاصة:

الهدف من البحث حساب تراكيز اليورانيوم وتوزيعه في عدد من اعضاء الأغنام التي تعيش في مناطق مختلفة من العراق. قيست تراكيز اليورانيوم في نماذج الانسجة بحساب الاثار المسجلة على كاشف الاثرCR-39 المتسببة من قصف اليورانيوم (U^{235}) بنيوترون حراري من المصدر النيوتروني (^{241}Am-Be) وبفيض 5×10^{3} $n.cm^{-2}.s^{-1}$.

ان أعلى تركيز لليورانيوم في نسيج القصبة الهوائية للحيوان في مدينة كربلاء (3.706ppm), أما اقل تركيزلنفس العضو كان في مدينة الفلوجة (0.127ppm) , وكذلك ايضا للرئة كان اعلى تركيز في مدينة كربلاء (2.313ppm) واقل تركيز في مدينة الفلوجة (0.082ppm). اما بالنسبة لنسيج الكبد كان اعلى تركيز لليورانيوم في مدينة الديوانية (1.156ppm) واقل تركيز في مدينة الفلوجة (0.153ppm). وكانت تراكيز اليورانيوم في نسيج القلب مختلفة عن النتائج السابقة لبقية الاعضاء حيث كانت متقاربة.

ان نتائج معدل تركيز اليورانيوم لكل الاعضاء في كل حيوان تراوحت ما بين (1.675-0.149ppm) حيث تشير النتائج الى ان اعلى معدلات لتراكيز اليورانيوم كانت في المنطقة الجنوبية من العراق.