Determination of uranium in fishes samples from selected regions in Iraq using neutron activation technique for nuclear track detectors

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Abstract:

To establish a base line against which future pollution may be measured, six common commercial species of Iraqi river fish were analysed for uranium content. The fishes studied were: *Barbus luteus, Barbus sharpeyi, Aspius heckle, Barbus heckle, Pampus argentues* and *Pilchard.* The fish samples were collected from two key governorates namely, Basrah (southern Iraq) and Babil (central Iraq). Uranium concentration in fishes samples was measured by using fission tracks registration in CR-39 detector that caused by the bombardment of (U^{235}) with thermal neutrons from (Am-Be) neutron source. The results show that the uranium concentrations in fish samples ranged from 1.78 ± 0.19 μg kg^{-1} to 8.31 ± 0.51 μg kg^{-1}. The results indicated that the mean value of uranium concentration in fish samples of Basrah governorate is higher than those of Babil governorate.

Key words: Uranium, Fish samples, Track detectors, Neutron activation technique

Introduction:

Uranium is a naturally occurring trace element, widely distributed in nature, and it exists in the form of solid, liquid and gaseous compounds [1]. It is not an essential element for life and can be toxic both to humans and the environment because of its radiological and chemical toxicity, which is a threat to human and environmental balance [2], [3], [4].

Uranium and its isotopes are useful in different nuclear and military industries. Humans are continually exposed to uranium through inhalation of air or ingestion of food and drinking water as well as in a lesser extent through the radiation it emits [4], [5]. Uranium is quickly absorbed by lungs and intestine. It enters the blood stream quickly and is deposited in the bones and other organs [6], [7], [8].

Its clearance from the bloodstream is relatively rapid, which causes mutations in DNA [2], [9]. Epidemiological studies on the human and animals have shown that uranium has many harmful effects on the kidneys, reproductive organs and several health problems [1], [10].

The environment in Iraq especially in the southern Iraq has been badly affected during the Gulf wars as a result of using the uranium weapons. Data from the epidemiological studies that carried out on the human in Iraq have shown exposure to high levels of radiological and chemical contaminants [1], [2], [11].

Therefore, the objective of the study is to establish the levels of exposure to uranium in fishes samples collected from different Iraqi cities.

Fission track analysis technique (FTA) with solid state nuclear track detectors (SSNTDs) CR-39 by using thermal neutron irradiation is normally used to determine the trace concentration of uranium in biological samples [12], [13], [14].

Materials and Methods:

The fish samples were collected from two governorates in Iraq namely, Basrah which is located in southern of Iraq and Babil which is located in the central of Iraq figure (1), where fish are the main sources of food. Various types of fish samples were collected from markets in Basrah and Babil governorates which included six common commercial species of Iraqi river fish are: *Barbus luteus, Barbus sharpeyi, Aspius heckle, Barbus heckle Pampus argentues* and *Pilchard.* About 1 kg of various fish, which are sufficient for getting the required amount of ash for fission track analysis technique, were taken to the laboratory for processing. The fishes were dried gradually, and then ashed at 450 ^{0}C.

The ashed samples were sufficiently grinded by using an agate mortar, and stored in plastic vials. The ashed samples of 0.5 g were mixed with 0.1 g of starch which is used as a binder. Thereafter, the blend was compressed into a pellet of 1 cm diameter and 1.5 mm thickness. The pellet was covered with CR-39 track detector on both sides and was put in a plate of paraffin wax at a distance of 5 cm from (Am–Be) neutron source with a thermal flounce equal to (3.024×10^{9} n cm^{-2}) for 7 days, to cause latent damage to the CR-39 detector due to ^{235}U (n, f) reaction. After the irradiation process, the CR-39 detectors were etched in (NaOH) solution with normality (N= 6.25) at temperature of 60 ^{0}C for 5 h. Olympus optical microscope with magnification of 400 × was used to recording the induced fission tracks densities. The fission track densities were measured on the surfaces, showing uniform distribution of uranium [1], [2].

Concentrations of uranium in the fish samples were measured by comparison between the tracks density that registered on CR-39 detectors around the samples pellet and that of standard samples pellet by using the following equation.

$$U_x = U_s\,(\rho_x/\rho_s) \qquad (1)$$

Where the symbols *x* and *s* represents the unknown and the standard, respectively; *U* is the uranium concentration in (μg kg^{-1}); ρ is the density of the induced fission tracks in (track / mm^2). The details of the technique are the same as reported [1], [2], [3].

Figure (1): Map of Iraq showing location of the study.

Results and Discussion:

Table 1 shows the uranium concentration in fish samples of Basrah governorate. Maximum value obtained was 8.31 μg kg^{-1} which belongs to Barbus heckel type, and the minimum value is 4.46 μg kg^{-1} in Pilchard type. The mean value of uranium concentration in fish samples of Basrah governorate is 6.47 ± 0.32 μg kg^{-1}.

Table 2 shows the uranium concentration in fish samples of Babil governorate. The maximum value of uranium concentration obtained is 4.75 μg kg^{-1} found in Barbus heckel type, whereas the minimum value obtained is 1.78 μg kg^{-1} found in Pilchard type sample. The mean value of uranium concentration in fish samples of Babil governorate is 3.10 ± 0.26 μg kg^{-1}.

From Tables 1 and 2 the highest and lowest value of uranium concentration in fish samples was found in Barbus heckel and Pilchard type, respectively. The cause behind such results can be attributed to bigness the age of the Barbus heckel fish where the uranium content in the body is correlated with the age of the living things, and this finding is in agreement with those of other researchers [2], [3].

Table (1): Uranium concentration in fish samples of Basrah governorate

Sample code	Fish sample	Uranium content in (μg kg^{-1}) ± S.D
1	Barbus luteus	5.55 ± 0.26
2	Barbus sharpeyi	6.94 ± 0.47
3	Aspius heckle	6.81 ± 0.38
4	Barbus heckle	8.31 ± 0.51
5	Pampus argentues	6.77 ± 0.35
6	Pilchard	4.46 ± 0.26
Mean ± Std Error		6.47 ± 0.32

Table (2): Uranium concentration in fish samples of Babil governorate

Sample code	Fish sample	Uranium content in (μg kg^{-1}) ± S.D
7	Barbus luteus	2.34 ± 0.21
8	Barbus sharpeyi	2.94 ± 0.18
9	Aspius heckle	3.24 ± 0.24
10	Barbus heckle	4.75 ± 0.28
11	Pampus argentues	3.56 ± 0.25
12	Pilchard	1.78 ± 0.19
Mean ± Std Error		3.10 ± 0.26

Figure 2 illustrates the mean value of uranium concentration in the fish samples of Basrah and Babil governorate. This figure shows that the mean value of uranium concentration in fish samples of Basrah governorate is two times higher than the uranium concentration in fish samples of Babil governorate. The reason can be attributed to that the Basrah governorate exposed to high levels of radiological contaminants during the Gulf wars, and the contaminated places haven't been limited or isolated to stop and avoid the spreading of this radioactive contamination to the environment [1], [2].

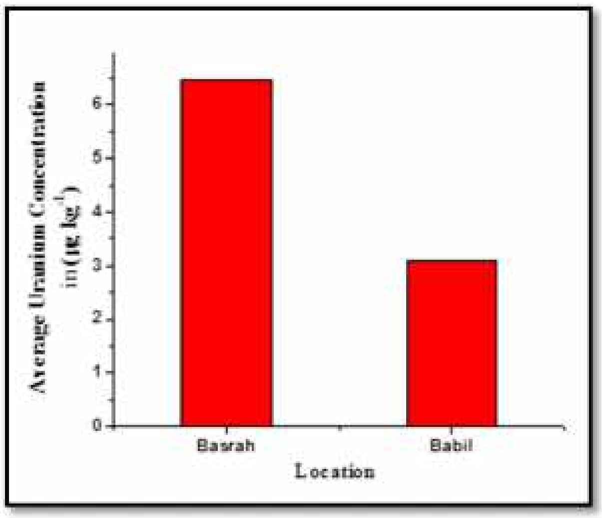

Figure (2): Uranium Concentration in fish samples as a function of location.

Conclusion:

The concentrations of uranium in selected fishes samples collected from Basrah and Babil governorate were measured using neutron activation technique for CR-39 nuclear detectors. The results obtained show that the concentrations of uranium in Barbus heckle fish are higher than other samples. The mean value of uranium concentration in fish samples of Basrah governorate is higher than the fish samples of Babil governorate.

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تحديد اليورانيوم في نماذج الاسماك من مناطق مختارة في العراق باستخدام تقنية تنشيط النيوترون لكواشف الأثر النووي

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الخلاصة :

لأنشاء خط اساس الذي يمكن ان يقاس به التلوث في المستقبل، تم تحليل محتوى اليورانيوم في ستة انواع شائعة تجارية من اسماك الانهر العراقية. الاسماك التي تمت دراستها هي: حمري، بني، شلك، كطان، سمتي (كاربي) وسمك الزوري. تم جمع عينات الاسماك من محافظتي البصرة (جنوب العراق) وبابل (وسط العراق). تم قياس تراكيز اليورانيوم في الاسماك بحساب الآثار المسجلة على كاشف الأثر CR-39 المتسببة من قصف اليورانيوم (^{235}U) بنيوترون حراري من المصدر النيوتروني (Am-Be) . أظهرت النتائج ان تراكيز اليورانيوم في الاسماك تراوحت بين ($1.78 \pm 0.19\ \mu g\ kg^{-1}$) الى ($8.31 \pm 0.51\ \mu g\ kg^{-1}$). وقد أشارت النتائج الى ان معدل تراكيز اليورانيوم في الاسماك من محافظة البصرة اعلى من تلك في محافظة بابل.

كلمات مفتاحية : يورانيوم، نماذج الاسماك، كواشف الأثر، تقنية التنشيط النيوتروني.