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Determination uranium concentration of teeth in Al-Samawa city using the CR-39 nuclear track detector

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ABSTRACT

In this research, The uranium concentration in teeth samples were measured using a CR-39 track detector and the fission tracks registration method., for 25 samples of teeth distributed across Samawa City, each weighing (0.7) grams and (2) mm in thickness. Exposed done after preparing the samples into small spherical pellets covered with a 1x1cm^2 CR-39 detector . These samples with detectors together were irradiated using an (^{241}Am-Be) source with a neutron flux (5x103 n.cm-2.s-1) for one week. These samples were compared with standard samples to find uranium concentration. The results show that the maximum value of uranium concentration was (2.273 ppm) and value of a minimum uranium concentration was (0.626 ppm) and the concentration of uranium in females was higher than in males, the concentration of uranium were affected by several factors: the region of study , gender and age of the human.

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تحديد تركيز اليورانيوم في الأسنان بمدينة السماوة باستخدام كاشف الأثر النووي CR-39

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الـــخُـــلاصـــة:

في هذا البحث تم قياس تركيز اليورانيوم في عينات الأسنان باستخدام كاشف الاثر -*CR* *39*وطريقة تسجيل أثار الانشطار ل ٢٥ عينة من الأسنان موزعة على مدينة السماوة ، وزن كل منها (٠.٧) غرام وسمك (٢) ملم . يتم تعريضها بعد تحضير العينات إلى اقراص دائرية صغيرة مغطاة بكاشف *CR-39* بمقاس ١ × ١ سم^2. تم تشعيع هذه العينات مع أجهزة الكشف معًا باستخدام مصدر (^{241}*Am-Be)* بتدفق نيوتروني (٥$x10^3$ $n.cm^{-2}.s^{-1}$) لمدة أسبوع

الكلمات المفتاحية:

تركيز اليورانيوم
كثافة الأثر
كاشف الأثر النووي *CR-39*
زمن القشط
المصدر النيتروني

واحد. تمت مقارنة هذه العينات مع العينات القياسية لمعرفة تركيز اليورانيوم. بينت النتائج أن القيمة القصوى لتركيز اليورانيوم كانت (٢.٢٧٣ جزء في المليون) وقيمة الحد الأدنى لتركيز اليورانيوم (٠.٦٢٦ جزء في المليون) وكان تركيز اليورانيوم عند الإناث أعلى منه عند الذكور. ويتأثر تركيز اليورانيوم بعدة عوامل منها: منطقة الدراسة والجنس والعمر للإنسان.

1. INTRODUCTION

Uranium is a radioactive and chemical element with the symbol (U) that is a heavy metal with a very high density (18.95 g/cm3, 1.7 times that of lead at 11.35 g/cm3). Metallic uranium has a high melting point (1132 Co) and boiling point (4131 Co), as well as a tensile strength comparable to most steels and a chemical reactivity equivalent to that of most steels [1]. There are three isotopes of uranium in nature. ^{238}U 99.276 percent, ^{235}U 0.718 percent, and ^{234}U 0.0056 percent are their mass concentrations. [2,3].

Radioactive compounds' nuclei are converted into other elements, either emitting or absorbing particles. With the release of alpha particles, ^{238}U decays into ^{234}Th [4]. The series ends with ^{206}Pb after alpha decays.

The ‘Actinium Series' is the name given to the decay chain of ^{234}U, with ^{234}Th being the next isotope in the chain. To attain a stable state with a decay energy of 4.679 MeV, the unstable nucleus loses energy by emitting ionizing alpha particles. By inhaling air or consuming contaminated food and water, this radioactive material can enter the bodies of humans and animals. [5].

The process by which the alpha particles released by ^{210}Po cause harm within the body was explained by Harrison et al. (2007) [6]. Ionizing radiations, such as alpha particles, have the potential to harm cells by destroying biological molecules such as DNA. The activity of alpha particles in the teeth is 10-15 times higher than in other body parts.

The central aim of autopsy tissue research has been to identify the primary alpha emitters, which are ^{210}Po, ^{226}Ra, and ^{238}U. These nuclei have activity values of 1.0-3.0mBq g-1, 0.2-0.3 mBq g-l, and 0.05 mBq g-1 in human tissues, respectively. [7]. The rate of radioactive transfer from the environment (i.e., air, soil, and water) to the human body determines the amount of radionuclides collected in the human body. Due to its great resolution and capacity to detect very low concentrations, track detectors are being used in several research to investigate alpha emission in biological samples.

In the bones, ^{238}U and ^{230}Th exhibit comparable distributions with lower amounts than ^{232}Th. These radioisotopes have the same chemical and physiological properties as Ca and are abundant in bone and teeth [8]. Because ^{226}Ra is somewhat transferrable in the physical environment, It's likely to be found in the bone. The ^{226}Ra is taken up and absorbed by the plants. [9].

Depleted uranium (DU) metal is widely used in armor-piercing military bullets in the United States and the United Kingdom. DU is a by-product of the uranium enrichment process that is equivalent to natural uranium but with a lower concentration of uranium-235 than natural uranium (0.72 percent vs. 0.2 percent). In a DU penetrator shell, the isotope uranium-238 accounts for 99.8% of the uranium. Uranium-238 is a radioactive isotope of uranium. The uranium particle produced by shell collision with military vehicles, on the other hand, may be inhaled or eaten by troops and civilians nearby. Because DU is chemically poisonous and only slightly radioactive, some critics claim that using it in battle has resulted in a slew of unforeseen health problems. Some skeptics believe that individual cases of leukemia have increased significantly [10].

This paper investigates the concentration of uranium in the dental bones in the areas of southern Iraq that were exposed to Internationally prohibited weapons in the Gulf War.

2. MATERIALS & TECHNIQUES:

1- Teeth samples are collected.

Twenty-five samples of teeth distributed in different areas and rural areas from Al-Muthanna city were obtained from the a study place, the weight of the sample (0.7 gm) and (2 mm) in thickness, teeth samples were covered with a 1x1 cm piece of CR-39 detector and put in front of the neutron source together.

2- Irradiation of the detectors

As shown in Fig (1), the pellets (tooth samples) were coated with a CR-39 detector and placed in a paraffin wax plate at a distance of 5cm from the neutron source (Am-Be), with a thermal neutron flux (5 103 n cm(-2) S(-1) for 7 days.

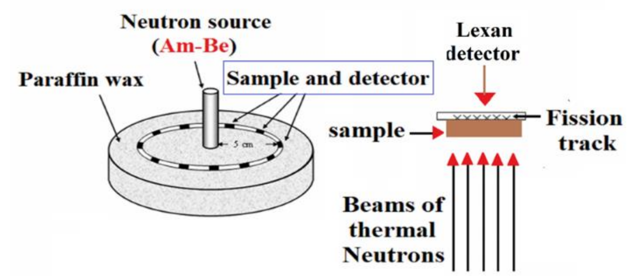

Figure 1: Set-up of the CR-39 detector for measuring uranium in teeth samples.

3- Chemical etching and scanning with a microscope:

The CR-39 detectors were removed after a week of irradiation and etched in a 6.25 N aqueous solution of NaOH kept at 60°C for 5 hours. The detectors were washed in distilled water and air dried.. The developed fission tracks were large and view with an optical microscope Novel type model (N-200M), equipped with a digital camera name ToupCame 2.0, model UCMOS00350KPA, manufactured by Hangzhou ToupTek Photonic. The number of the tracks in the detectors was count by computing a mean number of 10 visions. The track density for each case was calculated by dividing the mean fission tracks by the camera's field of view (0.052mm^2). The following relationship was used to calculate the density of the tracks _x in the detectors.:

$$\rho_x = \frac{N_{ave}}{A} \ldots\ldots\ldots (1)$$

Where:

ρx: Track density Track / *mm2*.

Nave: average of total tracks.

A: area of field view. mm^2

4- Uranium concentration

The fission-track method was used to detect uranium concentration by comparing the uranium concentration in tooth samples. The formula was used to figure out how much uranium was in the unknown samples [12].

$$\frac{Cx}{\rho_x} = \frac{Cs}{\rho_s} \ldots\ldots\ldots (2)$$

where

Cs, Cx are the uranium concentrations in parts per million (ppm) for the standard and sample, respectively.

Ps and x represent the track density (track/mm2) for the standard and unknown samples, respectively.

and

$$C_x = C_s \frac{\rho_x}{\rho_s} \ldots\ldots\ldots\ldots (3)$$

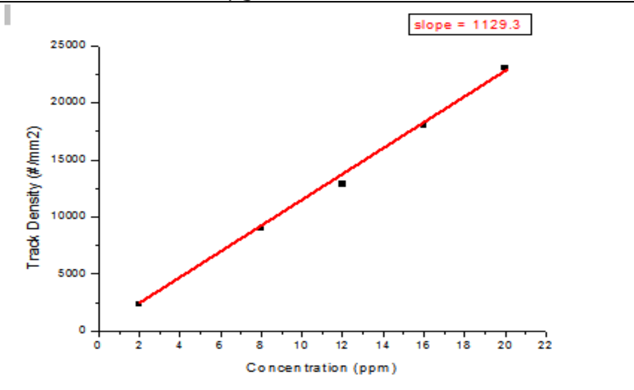

Figure 2: The uranium percentage and track density relationship.

Fig (2). Show the relationship between track density and uranium concentration when the etching time is five hours and (slope= 1129.3x).

3. RESULTS AND DISCUSSION

Table1: Uranium level and specific activity in teeth samples.

Samples code	Gender	Age	ρ_x Track density (Track/mm^2)	C_x Uranium concentration (ppm)	S.A The specific activity (Bq / Kg)
1	M	37	4277.22	1.053	13.003
2	M	55	9235.32	2.273	28.077
3	M	34	7041.48	1.733	21.407
4	M	66	7849.17	1.932	23.863
5	F	33	6374.81	1.569	23.863
6	F	45	4354.9	1.072	19.380
7	M	24	3554.3	0.875	13.239
8	F	43	7445.9	1.833	10.805
9	F	55	5336.27	1.314	22.637
10	M	7	2543.11	0.626	7.731
11	F	33	3374.81	0.831	25.422
12	F	32	8323.53	2.049	10.260
13	M	24	4267.33	1.050	25.305
14	F	40	4124.24	1.015	12.973
15	F	34	6910.34	1.701	12.538
16	M	23	8468.57	2.085	21.008
17	M	55	4468.11	1.100	25.746
18	F	56	7768.55	1.912	13.583
19	F	43	6357.33	1.565	23.617
20	F	33	9088.44	2.237	19.327
21	F	67	7790.55	1.918	27.630
22	M	32	4576.55	1.127	23.684
23	F	22	4777.68	1.176	13.913
24	F	43	7228.33	1.779	14.525
25	F	45	9131.13	2.248	21.975
Max			9235.32	2.273	28.077
Min			2543.11	0.626	7.731
Average			6186.719	1.522	19.009

Table 1 shows that the track density, uranium concentration and the specific activity for (25) samples in one-week irradiation; the result showed that the average track density was (6186.719 #/mm^2), uranium concentration (1.522ppm) and specific activity (19.009 Bq / Kg) for etching time five hours. These results disagree with the observation of (Alyaa A. Abd Al-Jabar, 2015) and (Alia A.Razzaq, 2013)[13,14] They both found that uranium concentration in dental samples by neutron activation is (0.071 ppm), (0.12 ppm).

Descriptive Statistics

Table 2: Descriptive Statistics for number of samples, age, track density and uranium con.

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Age	25	7	67	39.24	2.878	14.388
Track density	25	2543.11	9235.32	6419.4740	385.98828	1929.94140
Uranium con.	25	0.626	2.273	1.58020	0.095004	0.475022

This table showed the Minimum age was (7 year) and minimum uranium concentration (0.626 ppm) and Maximum age and uranium concentration (67 years), (2.273), respectively.

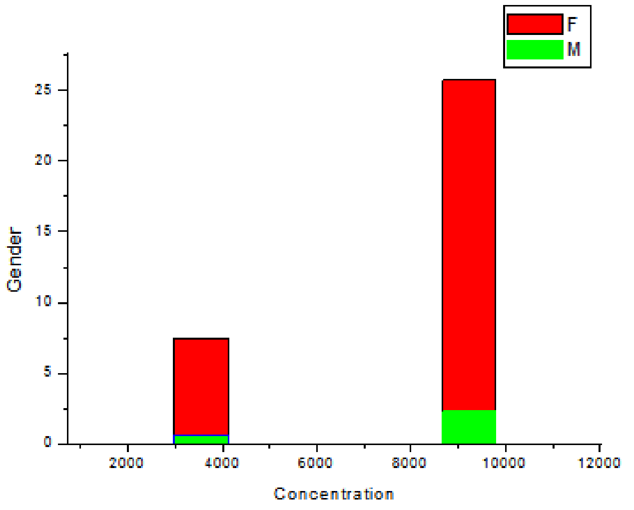

Figure (3): The relation between uranium concentration and Gender.

Figure 3 shows the high level of uranium in females' teeth compared to the concentration of uranium in males due to the division of cells in females.

4. CONCLUSION

1- Uranium concentration the females is higher than that of males in Samawa city.

2- The high percentage of uranium in Samawah governorate and especially in rural areas And areas that have been bombarded by internationally prohibited weapons.

3- There is a relationship observed between age and uranium concentration, A 7-year-old child with (deciduous teeth) has the lowest concentration of uranium (0.626), and this is evidence that there is a relationship between a person's age and uranium concentration, and the oldest age of a woman is 67 years with uranium concentration (2.273ppm).

4- The concentration of uranium were higher when compared with previous studies in all region in iraq and especially in females, and this is due to the lower percentage of blood compared to males or because of the nature of cell division in females.

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