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Measurement Of Uranium Concentration For Digestive System Samples In Two Governorates Of Iraq Using Fission Fragments Technique

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***Abstract*—In this study measurements of Uranium concentrations in Digestive System samples (Liver, Small intestine, Stomach, gallbladder and Colon), were this included two types of disease (Benign and malignant) tumors .Using neutron activation technique (thermal neutrons) emitted from the neutron source (^{241}Am-^{9}Be) With neutron flounce (1.8 x10^{11} n / cm^2), and by using technique of the nuclear fission fragments in solid state Nuclear track detector (CR-39). Studied different etching times of these detectors to reach optimized time by using the water bath for etching where Choose chemical solution (NaOH) with (6.25N) and a temperature (70°C) Considered the perfect conditions for etching, and show the time (90 min) the best etching time of the detectors affiliated for these tissue .The highest value of the concentration of uranium in the digestive system (0.068 ppm) and the lowest value (0.035ppm) with average (0.05ppm).**

Keywords—CR-39 detector; Uranium concentration; Fission Fragment; Digestive system; Benign tumor; malignant tumor; Human tissue

1.Introduction

Human Body Contains several Systems and The Digestive System is important for living peoples. The radio nuclides inside their bodies coming either from continues exposed to the natural and artificial radiation sources, or they are inside their bodies from birth [1]. Radiation and radio nuclides can expose the whole body (direct exposure) or expose tissue inside the body when inhaled or ingested. Different types of radiation vary in their ability to damage different kinds of tissue. All kinds of ionizing radiation can cause cancer and other effects such as damage to somatic cells and germ cells and thus involve almost all illnesses [2, 3]. Radiation can alter important molecules in human tissue and can also produce chemical changes in DNA, or don't controls that structure or function of the cells that make up the human body this led to biological effect including abnormal cells, causing further damage[4].The ionizing radiation damage to DNA is ascribed to both direct and indirect effects. Direct effects result from the direct interaction of the ionizing radiation with DNA, Indirect effects result from the interaction of DNA with reactive species formed by ionizing radiation [5]. Uranium may enter into drinking water or food chain from naturally-occurring deposits by leaching processes. About 98% of uranium entering the body via ingestion is not absorbed, the uranium that is absorbed into the blood, approximately 70% will be filtered by the kidney and excreted in the urine within 24 hours; this amount increases to 90% within a few days [6, 7]. On average, approximately 90µg of uranium exist in the human body from normal intakes of water, food and air, about 66% is found in

the skeleton, 16% in the liver, 8% in the kidneys and 10% in other tissues [7, 8].

2. Experimental

2-1 Collection and Preparation of Samples

Fifteen samples of human tissues were collected from two governorates (Baghdad and Maysan), these samples have been taken from digestive system (Liver, Small intestine, Stomach, Gallbladder and Colon), and these samples included two types of disease (Benign and malignant) tumors. Each samples burned, dried and powdered. A (0.2 g) of each sample was mixed with a (0.1 g) of binding material with chemical formula $(C_6H_{10}O_5)_n$. The formed mixture pressed by a hydraulic press into small pellets with a diameter of (12mm). Each pellet inserted between two pieces (1x1cm^2) of CR-39 with thickness (200μm).

2-2 Irradiation

For the irradiation test, an (^{214}Am–^{9}Be) neutron source of activity about (12 Ci), It emits thermal neutrons from the (n,f) reaction according to the following reactions [9]:

$$^{241}_{95}\mathrm{Am} \longrightarrow {}^{237}_{93}\mathrm{Np} + {}^{4}_{2}\alpha$$

$$^{9}_{4}\mathrm{Be} + {}^{4}_{2}\mathrm{He} \longrightarrow {}^{12}_{6}\mathrm{C} + {}^{1}_{0}\mathrm{n} + 5.71\ \mathrm{MeV}$$

a formed sandwich irradiated with this source as shown in figure (1) for seven days.

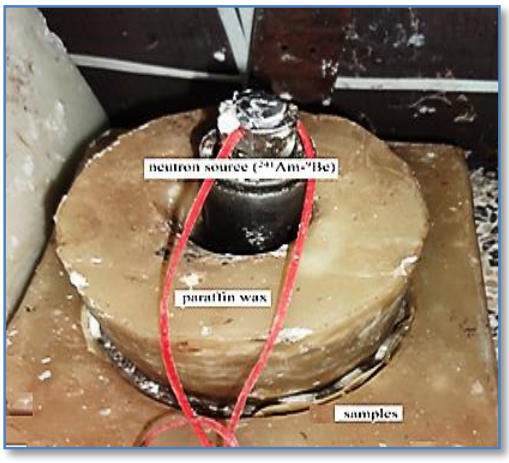

Fig (1) Neutron source (^{241}Am-^{9}Be)

2-3 Chemical Etching and Preparation of Etching Solution

The detectors were placed inside etching solution. This solution was prepared using volumetric flask and applying the following formula;

$$\mathbf{W = Weq \times N \times V} \quad \text{..... (1)}$$

Where;

W = weight of NaOH needed to prepare the given normality.

W_{eq} = equivalent weight of NaOH = 40.

N = normality equal to 6.25.

V = volume of distilled water = 250 ml.

and etched with (6.25) N of sodium hydroxide (NaOH) at (70^{o}C) temperature, After etching process detectors are taken out from the etchant solution mediated forceps and washed with distilled water and then dried, and Immersed in the solution for different time periods from (30-120 min) within the beaker topic in a water bath in order to get a good image to the fission fragments tracks .

2-4 Tracks Counting and Microscopic Viewing

After etching process the tracks produced in the detectors were enlarged, viewed, and counted by optical microscope is shown in figure (2) with (400X magnification), pictured by camera and finally counted.

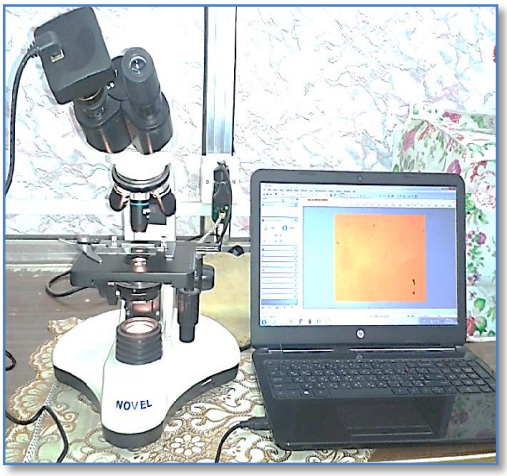

Fig (2) The optical microscope

2-5 Preparation of standard samples

Determination of uranium concentrations in general relativity using the comparison is based on a standard known concentration. For this purpose, it has been the preparation of different concentrations of uranium by using Uranium nitrate with the chemical formula. $[UO_2(NO_3)_2.6H_2O]$Concentrations Attended by the following relationship;

$$C_1W_1 = C_2W_2 \quad \ldots\ldots(2)$$

Where; C_1, C_2: Concentration of uranium standard known and unknown concentration . samples, respectively.

W_1, W_2: weight of standard samples known and unknown, respectively.

Was prepared five standard samples at different concentrations are (2, 4, 8, 16, 32) ppm, for the purpose of calibration has been pressing and Irradiation these standard are the same Conditions as samples under study.

3. Results and Discussion

3-1 Estimation of Etching Time

After irradiated CR-39 track detectors have been estimated the appropriate etching time for the uranium fission fragments. detectors were etched in the commonest etchant is an aqueous solution with normality NaOH in 6.25 N with technique water bath at temperature 70˚C by different etching time range from (30-120) min, as shown in figs (3a-3j). and in etching 90 min would be the sufficient time to get clear and large number of tracks as shown in fig (3g).

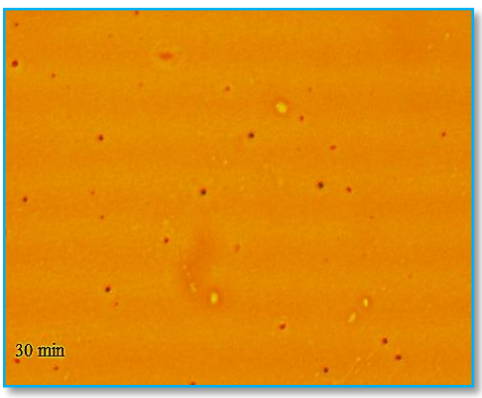

Fig (3a)

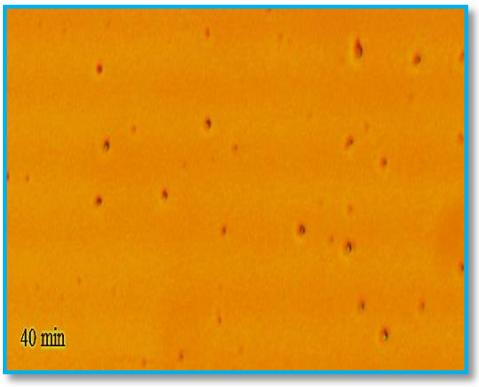

Fig (3b)

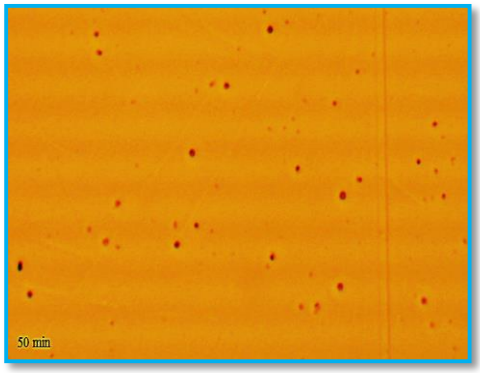

Fig (3c)

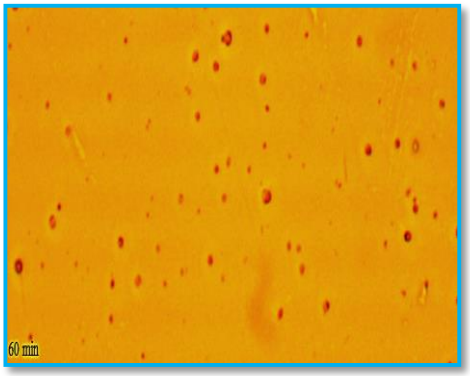

Fig (3d)

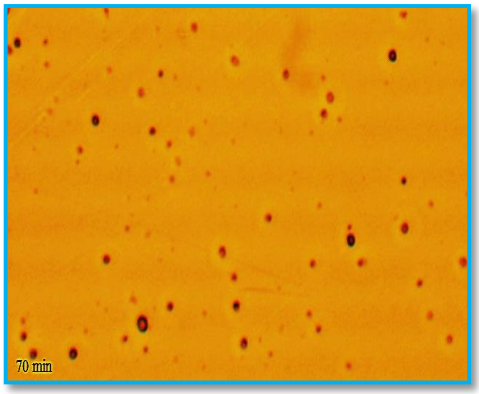

Fig (3e)

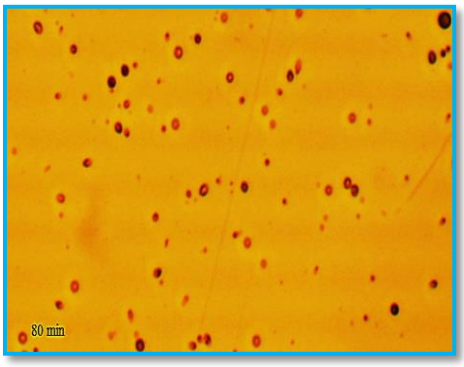

Fig (3f)

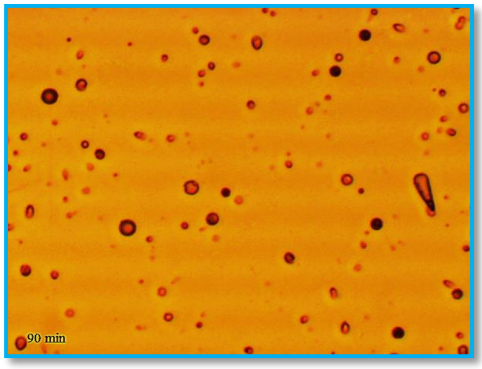

Fig (3g)

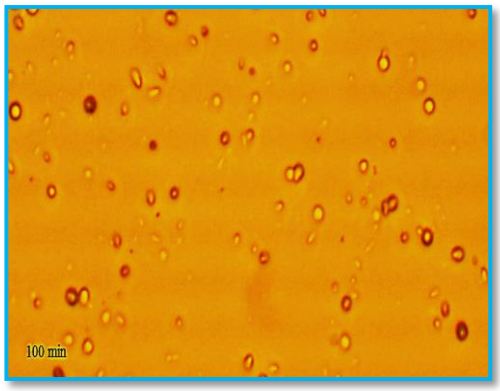

Fig (3h)

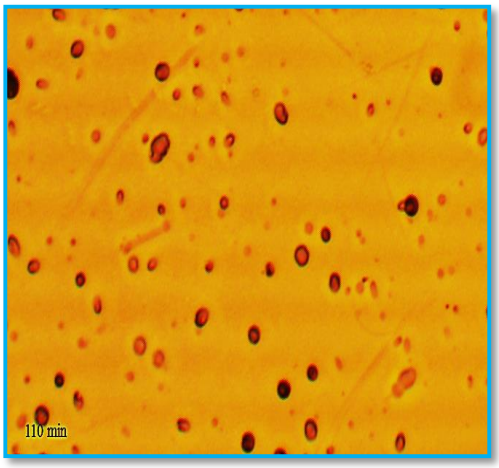

Fig (3i)

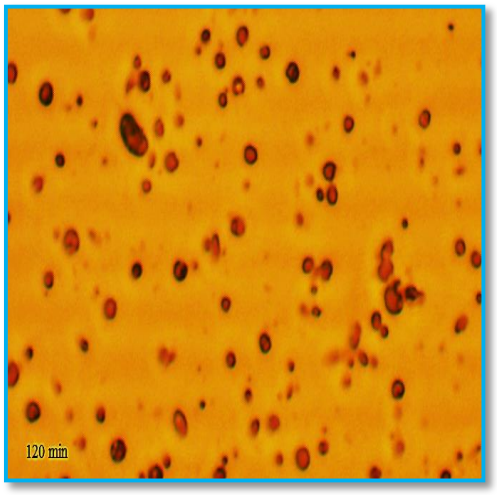

Fig (3j)

That's after time (90 min) the tracks will begin to decrease gradually until then disappear as shown in Figures (3h, 3i and 3j). And figures (4) Shows the number of tracks begin to rise gradually and then down after etching time 90 min then gradually decreasing the number of tracks.

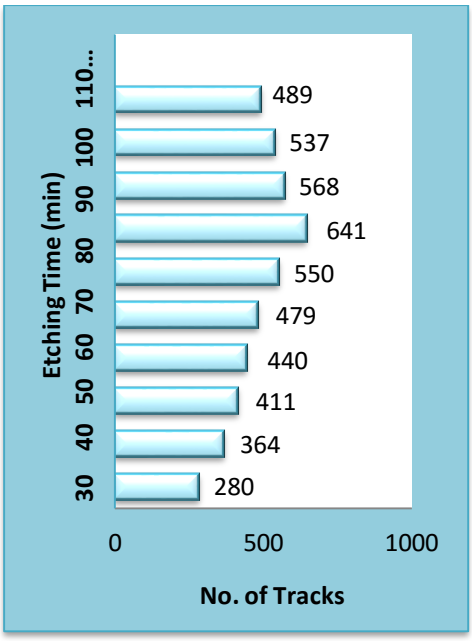

Fig (4): number of tracks for Fission fragments relative to etching time.

3-2 Calculation of Uranium Concentrations

In order to determine uranium concentration in tissue samples the observed track densities in tissue samples were related to the track density obtained in the standard of known uranium concentration. Because both samples were irradiated and etched under similar conditions, the uranium concentration standard as shown in fig.(5) was calculated by the relation:-

$$\frac{C_x}{C_s} = \left(\frac{\rho_x}{\rho_s}\right) x \left(\frac{I_s}{I_x}\right) x \left(\frac{R_s}{R_x}\right) \text{ …….. (3)}$$

Where;

C_x : is the uranium concentration in the sample. Cs: is the uranium concen-ration in the standard.

ρ_x : is the density of the induced fission tracks of the sample.

ρ_s: is the density of the induced fission tracks of the standard.

Ix: represents isotopic abundance of isotopes (U238, U235) in the samples containing depleted uranium (unknown) is equal to;

Ix = U238 / U235 = 99.79 / 0.201

= 495.25

Is: an isotopic abundance of isotopes (U238, U235) in the samples containing natural uranium standard samples is equal to;

Is = U 238 / U235 = 99.27 / 0.72 = 137.87

So the ratio (Is /Ix) equal to (R_x, R_S) 0.278 represent the average fission fragments in each of the unknown samples and standard on the sequence, which is approximately equal. Therefore, correction factor be (Rs / Rx ≈1). $C_{x\,(ppm)}$

$$= \frac{\rho_x}{slope} x\ 0.278 \text{ …. ……. (4)}$$

Were;

(Cs/ρs) represents an inverted-mile straight line (1 /slope) [10].

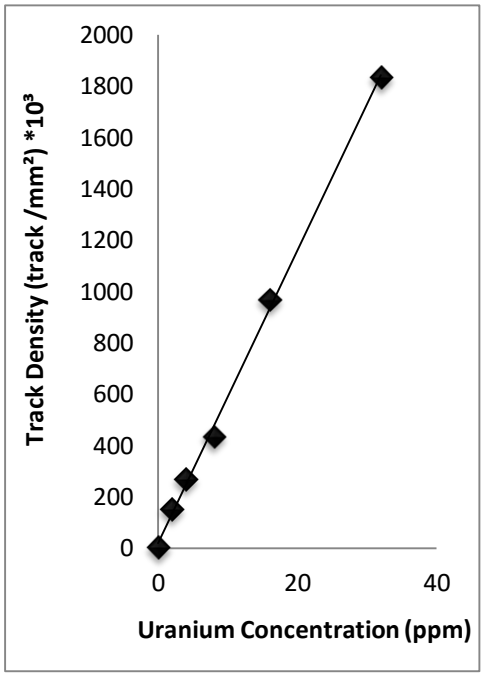

Fig (5): Track density resulting from uranium fission as a function of concentration of uranium in the standard samples.

3-3 Uranium Concentrations in Samples of Digestive System.

uranium concentrations have been measured in fifteen samples of human tissue (digestive system samples; Liver, Small intestine, Stomach, Gallbladder and Colon) as shown in table (1) each

table includes sample code, age, Type of disease, type of tissue, gender of the patient, city ,track density and. uranium concentration .In digestive System samples as in table(1) the highest concentration was (0.068ppm) in (D3) belong to the examined man sample (72) year with disease Malignancy tumors in Stomach , while the lowest concentration was (0.035ppm) in (D11) belong to women samples aged (73) year with disease malignancy tumors in gallbladder.

Table (1): Uranium concentrations in digestive System samples measured by (CR-39)

Sample code	Tissue (Type of disease)	City	Gender (Age year)	Track Density (track/mm ^{2} x10^2)	U. Conc. (ppm)
D1	Stomach (Ca)	M	F (43)	11767	0.06
D2	Stomach (Bi)	M	F (58)	7800	0.04
D3	Stomach (Ca)	M	M (72)	13317	0.068
D4	Small intestine (Ca)	M	F (41)	10383	0.053
D5	Colon (iB)	B	M (30)	7567	0.039
D6	Colon (Bi)	B	M (45)	9067	0.047
D7	Liver (Bi)	B	F (47)	10717	0.055
D8	Gallbladder (Bi)	B	F (20)	11350	0.058
D9	Gallbladder (Bi)	B	M (53)	8483	0.044
D10	Gallbladder (Bi)	B	F (30)	11450	0.059
D11	Gallbladder (Ca)	B	F (73)	6750	0.035
D12	Gallbladder (Bi)	B	F (23)	7617	0.039
D13	Gallbladder (Bi)	B	M (12)	9867	0.05
D14	Gallbladder (Bi)	B	F (36)	9417	0.048
D15	Gallbladder (Bi)	B	F (34)	10950	0.056
Average				9766.8	0.05

Ca ; Refers to a malignant tumor.
Bi ; refers to a benign tumor.
M ; refers to City of Maysan.
B ; refers to City of Baghdad.
F ; refers to femal .
M ; refers to mal.

In figuer (6) shown as uranium concenteration in digestive system arange mente descending highest since the start of the stomach tissue (0.056ppm) gradually least concentration of uranium in the colon tissue (0.043 ppm).

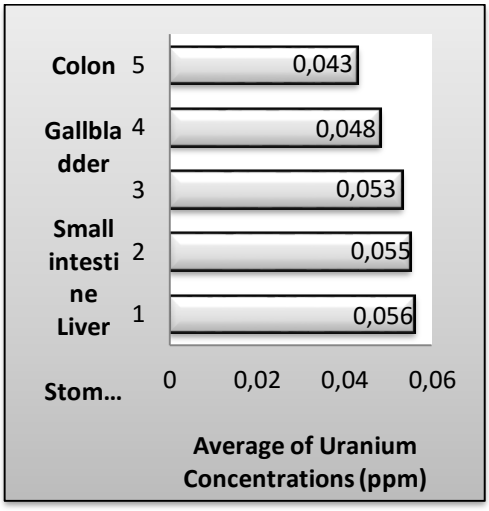

Fig (6) Average of uranium Concentration in the digestive System samples

Conclusions

From our research we can conclude that the number of track begin to appear when the etching time is (30) min, Then gradually increased to the time (90) min which is the highest number of tracks and More clear after then decreased gradually and appear unclear with increasing etching time. the optimum etching time for fission fragments in CR-39 detector is (90) min when using water bath technique (6.25) N of sodium hydroxide (NaOH) solution at (70 ^{o}C) temperature. The Average of uranium concentration in stomach tissue higher than other digestive system tissue (0.056ppm) where the concentration in liver tissue is (0.055ppm) and (0.053ppm) in small intestine, and the average of concentration in gallbladder and colon(0.048ppm),(0.043ppm) Respectively. the highest concentration of uranium in Stomach tissues is malignancy tumors samples was (0.068ppm), while the lowest concentration in gallbladder tissue is malignancy tumors samples

was (0.035ppm), this indicated that malignancy is not only caused by radiation, But other factors such as age and the surrounding environment, food and drink for each person affect the increase uranium levels in body tissues This shows us in previous work [11].

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