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Measurement of Alpha Emitters Concentration in Tomato Fruits Using CR – 39 Plastic Track Detector

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Abstract:

Our country suffered from pollution translation as a result to the wars events, so, it is necessary to measure the amount of radiation in the fields that are of indirect contact with human life and health. The main aim of the present work is to measure the concentration of alpha emitters in tomato fruits collected from different farms in Al – Basra governorate in the south of Iraq. Nuclear track detectors of type CR – 39 are used as a detection device and Can technique as a detection technique. Results show that the maximum concentration recorded is sample no.7 of site Al – Rafidhya which was equal to (6.9621 ± 0.111) ppm and sample no.1 of site Lothan with concentration equals to (4.9236 ± 0.117) ppm. The minimum concentrations were in sample 6 of site Al – Lehaiss (1.5360 ± 0.084) ppm followed by sample 9 of site Malhan which recorded (1.6840 ± 0.111) ppm (20.208 ± 1.332 Bq/m^3).

Key Words: Alpha Emitters, Tomato fruits, CR – 39 plastic track detector, Can technique.

Introduction:

Humans are primarily exposed to natural radiation from the sun, cosmic ray and natural occurring radioactive elements found in the earth crest [1]. Natural radiation contributes to about 80% of the whole received dose and this is rather important [2]. AttentioN needs to be paid to the exposUre from aRti&icial sOurces which represent 20% of the total dose [3]. Changes in the natural environment resulting from the process of economic, social and culturaL development and its multifarious utilization may frequently lead to unnecessary exposure of the population to natural radiation [4].

The most significant particle effect on humal health is alpha particle. From a radiation stand point, alpha particles are easily stopped by a thin absorber such as a paper or the dead layer of skin, inside the body; alpha emitters are highly significant because these deposit nearly all their energy in a very small volume [5]. Alpha can enter body in different manners such as food, water, air. The radio – nuclides in such ways are called "internal emitters". Uranium is a major source of alpha emitters. Plant ash normally contains 0.2 – 1 ppm uranium [6]. Plants take up radiation (especially radon gas) from the soil environment if grown on soil containing it. It is suggested that radiation is taken up by mass flow but at the leaf mesophy it diffuses independently on water [7]. From this point of view, studying alpha emitter's concentration in food or plants is very important.

In this work a measurement of alpha emitter's concentration in tomato fruits was done. Tomato

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fruits were chosen for study since it is the most popular food to Iraqi people. A comparison of results with the international permissible limits is given. The advantage of SSNTD's under studies made them an excellent tool for making inexpensive in situ measurement to radiation. CR – 39 plastic track detectors are considered to be the more suitable to measure alpha emitters in the environmental samples due to their high simplicity, sensitivity, rapidity and cheapness [7]. Can technique, which is found to be the most appropriate and the most widely used technique due to its simplicity as well as being economic [8], was chosen as a working technique.

Material and Methods:

- Tomato samples:
  Ten samples have been collected from different farms in Al – Basra governorate. Table (1) shows the sites of samples.

  Table (1) The sites of samples collection in Al-Basra Governorate.

Sample code	Sample site
1	Lothan
2	Joyraa
3	Al – Raha 1
4	Al – Sheiyba
5	Um – Anayich
6	Al – Lehaiss
7	Al – Rafidhya
8	Al – Najmy
9	Meilhan
10	Al – Raha 2

-
- Detectors:
  CR – 39 plastic track detector in the form of a sheet of 250 µm thick, supplied by Pershore Moulding LTD Co./ U.K., was used. The detector was cut to small pieces of 1×1 cm^2 area and kept at normally laboratory conditions of temperature and humidity.
- Etching process:
  Sodium hydroxide solution was used as an etching solution with 6.25N
- Water bath:
  A water bath of the type Labsco, Germany was used as an etching bath, containing thermostat operated over 20 – 110 ºC range. The liquid bath was distilled water, and the accuracy of regulation of temperature was better than ± 0.1 ºC.
- Optical microscope:
  The etched tracks counting were carried out using an optical microscope of type Bausch and Lamb / Japan. The magnification used was up to ×400.
- Neutron Irradiation source:
  A rod of Am – Be source of 5 × 10^3 n/cm^2.sec flux was used for the irradiation test. It emits fast neutrons from the ^{9}Be (α , n) ^{12}C.

Experimental Method:

Tomato fruit samples have been collected from different farms in the south of Iraq and especially from Al – Basra governorate. A certain weight of each sample has been dried in the oven. After drying process, a weight of 0.5 g of each sample is taken, mixed with KBr as a binding material and pressed into a pellet of 1 cm diameter 1.5 mm thickness using mechanical press to a pressure up to 10 tons. The pellets were covered with CR – 39 detectors on both sides and

enclosed in aluminum capsules, put in a plate of paraffin wax at a distance of 5 cm from the (Am – Be) neutron source. The samples irradiated to 7 days. Fig (1) shows a simple geometry for irradiation process.

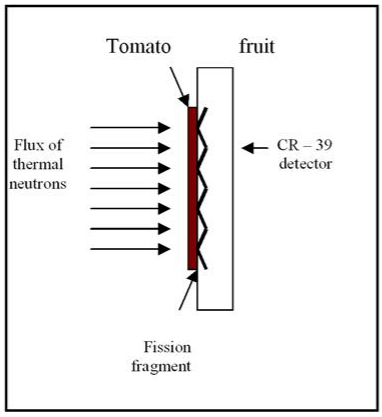

Fig (1) represents a simple geometry of the irradiation process.

After the irradiation, detectors were etched in an aqueous solution of NaOH with 6.25 N at 60 ºC for 4 hrs. The produced fission track density was measured using the optical microscope. Standard samples have been prepared for calibration process. Alpha – Emitter's concentrations in Tomato fruits samples were measured, using the equation:

$$C_x = (\rho_x / \rho_s) \times C_s \quad \ldots (1)$$

Where:

C_x = alpha emitters concentration in the sample (in ppm)

ρ_x = track density of the sample (track / mm^2)

ρ_s = track density of the standard sample (track / mm^2)

C_s = alpha emitters concentration in the standard sample (in ppm).

By comparison between track density estimated in the detectors of the samples and that of the standard pallets, equation (1) will be :

$$C_x = \rho_x / \text{slope} \quad \ldots\ldots\ldots\ldots (2)$$

The last equation was used to calculate radon concentration in samples (in ppm). The results obtained were arranged in Table.

Results and Discussion:

The final results of alpha - emitters concentrations (in ppm) and (in Bq/m^3) in the ten different samples of different farm sites in Al – Basra governorate were arranged in Table (2), moreover, a comparison of results concentrations to permissible limits of Environmental Protection Agency EPA, which is equal to 1.5 ppm (18 Bq/m^3) for each sample was calculated and presented in Fig (2).

Table (2) represents alpha - emitters concentrations (in ppm) and (in Bq/m^3) in Tomato samples

Sample code	Sample site	Alpha – Emitters concentration (ppm)	Alpha – Emitters concentration (Bq/m^3)
1	Lothan	4.9236 ± 0.117	59.0832 ± 1.404
2	Joyraa	2.1737 ± 0.1489	26.0844 ± 1.7868
3	Al – Raha 1	3.8972 ± 0.081	46.7664 ± 0.972
4	Al – Sheiyba	3.4615 ± 0.118	41.538 ± 1.416
5	Um – Anayich	2.5136 ± 0.102	30.1632 ± 1.224
6	Al – Lehaiss	1.5360 ± 0.084	18.432 ± 1.008
7	Al – Rafidhya	6.9621 ± 0.111	83.5452 ± 1.332
8	Al – Najmy	2.1022 ± 0.130	25.2024 ± 1.56
9	Malhan	1.6840 ± 0.111	20.208 ± 1.332
10	Al – Raha 2	2.6261 ± 0.257	31.5132 ± 3.084

From results, the maximum concentration recorded in sample 7 of site Al – Rafidhya which was equal to (6.9621 ± 0.111) ppm (83.5452 ± 1.332 Bq/m^3) and sample 1 of site Lothan with concentration equals to (4.9236 ± 0.117) ppm (59.0832 ± 1.404 Bq/m^3) respectively. While the minimum concentrations were in sample 6 of site Al – Lehaiss which recorded (1.5360 ± 0.084) ppm (18.432 ± 1.008 Bq/m^3) followed by sample 9 of site Malhan which recorded (1.6840 ± 0.111) ppm (20.208 ± 1.332 Bq/m^3) respectively. By comparing the results obtained in this research with the results in other previous researches of the same type of food in different sites in Iraq and especially with Al – Basra sites [9], it is found that the results in this work are in agreement with some arising from these results. This may refer to the site of samples collection, the type of technique used, since the previous researches used another type of technique, and to the error associated with the experimental measurements. Also it is a fact that is not absent from many scientists that Al –Basra governorate was a War land from 1991 until 2003. Taking in concern that the samples were collected during summer 2000 and the study and measurements were done in the same year.

Conclusions:

From this work we can conclude the following points:

1. The maximum concentration recorded in sample of site Al – Rafidhya and of site Lothan respectively.
2. The minimum concentrations were in site Al – Lehaiss followed by site Malhan respectively.
3. All samples obtained are on agreements with the previous results with some arising in some sites.

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قيـــاس تركيز باعثـــات الفـــا في ثـمرة الطماطم باستـــعمال كاشـف الاثـــر البلاستيكي CR – 39

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كلمات مفتاحية: باعثات الفا, ثمرة الطماطة, كاشف الاثر البوليمري CR – 39 , تقنية القدح.

الخلاصة:

عانى بلدنا من كثرة انتشار الملوثات ابان الحروب التي مرت به, لذلك من الضروري قياس و دراسة كمية الملوثات و خاصة المشعة في المجالات التي تؤثر في حياة الانسان. يهدف البحث الحالي الى قياس كمية باعثات الفا في ثمرة الطماطة التي تم جمعها من مواقع مختلفة من محافظة الصرة جنوب العراق. شملت الدراسة 10 مزارع مختلفة تزرع هذا النبات. تمت عملية القياس باستعمال كواشف الاثر النووي الحالة الصلبة من نوع CR – 39 و تقنية القدح كتقنية قياس. بينت النتائج ان اعلى المواقع في تركيز باعثات الفا هو نموذج الرافضية حيث سجل تركيزا قدره (6,9621 ± 0,111) جزء بالمليون (83,5452 ± 1,332 بيكرل/م^3) و نموذج موقع لوذان بتركيز قدره (4,9236 ± 0,117) جزء بالمليون (59,0832 ± 1,404 بيكرل/م^3) بالتتابع, بينما اقل المواقع تركيزا هو نموذج اللحيس حيث سجل تركيزا قدره (1,5360 ± 0,084) جزء بالمليون (1,008 ± 18,432 بيكرل/م^3) يليه نموذج موقع ملحان حيث كان تركيز باعثات الفا فيه مساوي الى (1,6840 ± 0,111) جزء بالمليون (20,208 ± 1,332 بيكرل /م^3).