Radon Concentration measurement in an Imported Tea using Nuclear Track Detector CN-85

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Abstract
The present paper aims to determine the radon concentration in a ten different imported samples of tea collected from Iraqi local markets. Solid state nuclear track detectors CN–85 was used to record the tracks of alpha particles released from radon content within the samples. A cylindrical chambers of U-shape containing the grained samples were used for irradiating the detector. The results showed that the highest concentration of radon was 45.97 kBq/m^3 found in Jihann tea, while the lowest value is recorded in Mahmoud tea which was about 25.44 kBq/m^3. The radioactivity of radon content in the samples which is equivalent to obtained values is found between (811.46-1446.29) pCi/kq. The obtained radon levels is within the natural limits of the activity concentrations of the naturally occurring radionuclides in foods, and this will not form any risk on the human being life.

Key words: *Radon concentration, CN-85 detector, radon in tea.*

Introduction
Radiation generally either natural or that man-made for different purposes, and human are exposed to various levels of radiation. Impact of radiation on environment last many years which can affects the gene structure for humans and animals, causing genetic abnormalities on the and the following generations, for this reason radiation pollution musts impact on water and soil can be transferred through the food chain to humans and animals [1]. The food chain as the most important and critical paths in the speed of transmission of radioactive contaminants as aggregates of different neighborhoods in the food chain is contaminated and increasing the proportion of radioactive materials such as plants, animals and their products [2].

The human body can be contaminated with the radioactive material by eating plants or the meat of animals that feed on plants that contain radioactive material originating from the main soil the plant absorb such materials with other natural materials are classified in construction, as well as drinking water and fluids where the water contains a low dose, breathable air, which is the main source of natural radioactive dose that reaches inside the human body and the primary source of radon gas found in the earth's atmosphere generated by the automatic decomposition of uranium [3]. Many researchers interested in studying radioactivity radiation and environmental pollution, has a team of researchers to disclose depleted uranium in different locations of southern Iraq [4, 5], while the other team to study the radioactivity of Iraqi building materials [6, 7], others studied radioactivity of the soil, medicinal herbs, water, milk and annuals [8, 9], another researcher found radon content in the types of imported tea samples using the detector CR-39 was up (24-51) kBq/m^3 [10].

In this paper the current concentrations of radon in different samples of imported tea in the local Iraqi markets will be identified using the nuclear track detector CN-85.

Calculations
The measurement of radon concentration is based on identifying the constant K, which is basically related to the geometry of the chamber used in irradiation process. The constant K can be related to the number of tracks formed in the detector by the following equation [11]:

$$\rho = KCT \quad \ldots\ldots\ldots\ldots (1)$$

Where ρ is the track density (Tr/cm^2), K is the diffusion constant measured by length unit (cm), C is the concentration of radon in the air space of the irradiation chamber, in (Bq/cm^3), T is the irradiation time in (s) and D is the track density rate (Tr.cm^{-2}.s^{-1}) which could be given by the following equation [12].

$$D = \rho/T = KC \quad \ldots\ldots\ldots\ldots (2)$$

As the diffusion constant K depending on the geometry of the chamber, so for the cylindrical chamber of U- shape, the constant K can be given by [11].

$$K = \frac{1}{4} r \left(2\cos\theta_c - \frac{r}{R_\alpha}\right) \quad \ldots\ldots\ldots\ldots (3)$$

Where r is the opening radius of the cylindrical tube which is about 19 cm. θ_c the critical angle of CN-85 detector for particles incidence which is less than it the etched tracks formed by the incident particles in the detector can't be revealed by chemical etching process. The critical angle for CN-85 is about 25^o. R_α is the range of alpha particles emitted into the air and equals to 4.15cm.

Consequently, substituting the above values of the parameters in equation (3), the diffusion constant K for used cylindrical tube is found to be 0.454 cm using the detector CN-85.

Considering equations (2) and (3), the track density rate (Tr.cm^{-2} s^{-1}) is:

$$D_{Rn} = \frac{1}{4} Cr \left(2\cos\theta_c - \frac{r}{R_\alpha}\right) \ldots\ldots\ldots\ldots (4)$$

By which the concentration of radon in the air space of the cylindrical chamber C (Bq.m^{-3}) can be estimated.

Finally the concentration of radon content within the samples (C_s) can also be calculated using the following equation [12]:

$$C_s = \lambda_{Rn} C \, ht/L \quad .... (5)$$

Where

λ_{Rn}: radon decay constant (0.1814 d^{-1}) [11].

h: the distance between the surface of the sample and exposed surface of the detector (9.5cm).

L: the thickness of the sample in the irradiation chamber (1.5 cm)

t: the Exposure time (60 d).

Methodology

The detector CN-85 of thickness 200μm and dimension (1×1) cm^2 is exposed to tea samples for 60 days. Ten different kinds of an imported tea available in the local market have been used to determine radon concentration. The kinds of tea namely are: Ahmed, Mahmoud, Spinners, Green, Lipton, Apple, Goose, Jihan, Bluebell and Prairies.

The nuclear track detector CN-85, considering long term measurement technique, have been used to investigate the tracks of alpha particles emitted by radon gas released from the sample. The tea samples were grained to get a homogeneous and fine powder to ensure a consistent distribution of radioactive materials in the samples content.

A 5 g of each grained sample is used in a detection process. The grained samples were placed in an irradiation chambers of a cylindrical U-shape the opening diameter is 2.38cm. The chambers were tightly sealed and left for 22 days to get secular equilibrium up to 98 % between radon and radium decays from the sample contents. After 22 days, and to prevent the leakage of decayed radon out of the chamber space the covers of the chambers were quickly replaced by another ones and CN-85 detector pieces with dimension (1×1) cm^2 and thickness 200 μm were fixed beneath the covers that again tightly sealed keeping the distance between the detector and sample surfaces about 9.5 cm to prevent reaching of thoron to the detector.

Therefore, the irradiation process was continued for 60 days, and then detectors pieces were raised from the irradiation chambers and chemically etched to reveal the alpha tracks released by radon content within the samples. Then the set of detectors were etched by aqueous NaOH solution of 2.5 N at 60±1°C. The number and density of the tracks were accounted using an optical microscope. The radiation background is measured for the same duration time that of 60 days using same irradiation chamber with no sample. The background was found equal to 416.66 track/cm^2 which is subtracted from the measured densities of the tracks found by the samples.

Results and Discussion:

One of the sources that forms large risk on the human being life and it is so important to determine it is the radon gas inhalation from different types of materials into the human body.

Table (1) shows the kinds of the tea samples and the radon concentration in both the space air of irradiation chamber and within the tea samples used. It is shown that the radon level in the tea sample used ranges between (22.530 - 40.711) kBq/m^3 or (30.054 - 54.307) Bq/kg, as the lowest level is found in Mahmoud tea and highest one is in Jihan tea. These values are equivalent to (811.46-1446.29) pCi/kq which represent the effective radon content in the samples which may form a risk on the human being life.

The results obtained is found in a good agreement with the values that found by [10] which ranges between (24 – 51) kBq/m^3 for a certain types of an imported tea in the local market of Mosul city using the nuclear detector CR-39 .

Table (1): Tea samples and the Effective radon content

Tea title	Tracks density ρ(Tr/cm^2)	Concentration of radon in the air space C_s(Bq/m^3)	Effective radon content in the sample C_s		
			(kBq/m^3)	(Bq/kg)	(pCi/kg)*
Tea Mahmoud	769.23	326.84	22.530	30.054	811.46
Tea Spinners	917.15	389.70	26.863	35.834	967.52
Tea Bluebell	982.24	417.35	28.768	38.376	1036.15
Apple Tea	1020.71	433.70	29.896	39.880	1076.76
Ahmad Tea	1050.29	446.26	30.762	41.036	1107.97
Green Tea	1084.3	460.71	31.758	42.364	1143.83
Lipton Tea	1168.6	496.53	34.227	45.658	1232.77
Tea Prairie	1198.22	509.12	35.095	46.816	1264.03
Tea Goose	1342.10	570.25	39.309	52.437	1415.80
Tea Jihan	1390.00	590.60	40.711	54.307	1466.29

* 1Bq/kg is equivalent to 27 pCi/kq

Conclusions

The study of radon exhalation rates from different types of food samples is important for understanding the relative contributions of individual materials to the total radon content found inside the body. It found that the radon concentrations differ from one type to another of tea samples. The value of radon content in different food samples is due to the naturally occurring of uranium isotopes in soil. It can be noted that the obtained values which range between or (30.054-54.307) Bq/kg are in general two orders of magnitude lower than the ICRP values cited (1-1000) Bq/kg for activity concentrations of the naturally occurring radionuclides in foods [13].

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قياس تركيز الرادون في الشاي المستورد باستعمال كاشف الاثر النووي CN-85

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الملخص

يهدف البحث إلى قياس تركيز الرادون في عشر عينات مختلفة من الشاي المستورد والتي جُمِعت من الأسواق المحلية العراقية. أُستعمل كاشف الأثر النووي الصلب CN-85 في تسجيل آثار جسيمات ألفا المنبعثة من الرادون المُتضَمن في النماذج، وقد أُستعملت حجرات اسطوانية على شكل–U تحتوي على النماذج المطحونة في عملية تشعيع الكاشف. أظهرت النتائج إن أعلى تركيز للرادون بلغ 45.97 kBq/m^3 في شاي جيهان وان اقل تركيز وُجِد في شاي محمود وكان بحدود 25.44 kBq/m^3. إن النشاط الإشعاعي للرادون المحتوى في النماذج والمكافئة للقيم التي تم الحصول عليها هي في مدى pCi/kq (811.46-1446.29). إن مستويات الرادون التي قيست تقع ضمن الحدود الطبيعية لتراكيز النشاط الإشعاعي الناتج من النويدات المشعة في الأغذية، وهي لا تشكل خطورة على الحياة البشرية.