



## Measurement of $^{222}\text{Rn}$ gas Concentrations and Radon Exhalation Rates in Some Cigarettes Tobacco Samples

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Received: 13/1/2021

Accepted: 26/3/2021

### Abstract

Twelve cigarette tobacco samples of various brands and origins were gathered from local markets of Iraq. The  $C_{\text{Rn}}$  was determined utilizing CR-39 track detectors which were exposed to the various brands of cigarettes tobacco for 45 days. The results demonstrated that the highest value of  $^{222}\text{Rn}$  concentration was ( $157 \text{ Bq/m}^3$ ) in Macbeth cigarette sample of Brazilian origin and the lowest value of  $C_{\text{Rn}}$  was ( $76.3 \text{ Bq/m}^3$ ) in Sumer cigarette sample of Iraqi origin, with an average value of ( $106.53 \pm 22.3 \text{ Bq/m}^3$ ). The outcomes have demonstrated that cigarettes of a Brazilian origin contain higher  $C_{\text{Rn}}$  than other studied samples, however, it is still less than some other average values given in the literatures.

**Keywords:**  $^{222}\text{Rn}$ , cigarette samples, (CR-39) detector, tobacco.

### قياس تراكيز غاز الرادون ومعدل الرادون المنبعث من بعض نماذج تبغ السكائر

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### الخلاصة

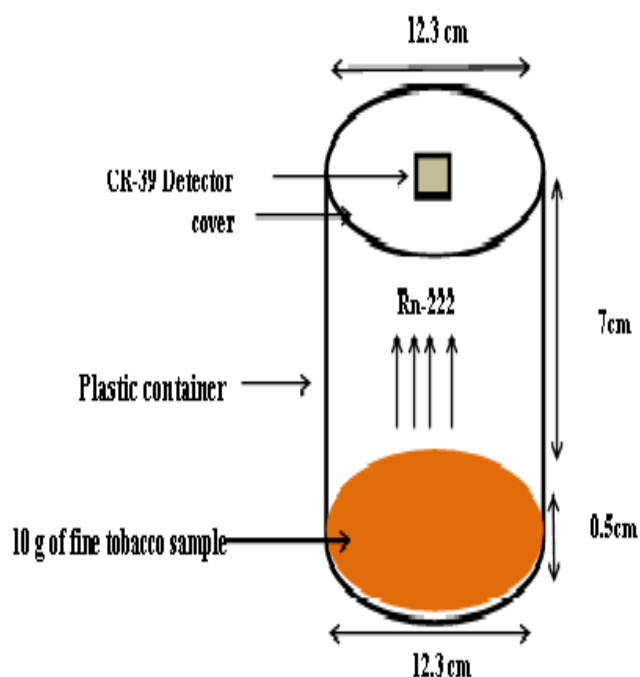
تم جمع اثني عشر عينة من تبغ السكائر من الأسواق لمختلف العلامات التجارية و المنشئ، وقد تم تحديد تراكيز غاز الرادون باستخدام كاشف CR-39 التي تعرضت لماركات مختلفة من تبغ السكائر لمدة 45 يوماً. أظهرت النتائج أن أعلى قيمة لتركيز غاز الرادون كانت 157 بيكريل/م<sup>3</sup> في عينة سجائر ماكبث من أصل برازيلي وأقل قيمة تراكيز غاز الرادون كانت 76.3 بيكريل/م<sup>3</sup> في عينة سجائر سومر من أصل عراقي، بمتوسط قيمة  $106.53 \pm 22.3$  بيكريل/م<sup>3</sup> أظهرت النتائج أن السجائر من أصل برازيلي تحتوي على تراكيز غاز الرادون أعلى من العينات الأخرى المدروسة، ومع ذلك، فإنها لا تزال أقل من بعض القيم المتوسطة الأخرى الواردة في الأدبيات.

## 1. Introduction

Numerous sorts of tobacco are grown for a variety of uses. The sorts of tobacco vary according to tobacco classes according to plant density, manipulation of nitrogen fertilization, height, time of topping, harvesting and curing which normally and favorably influence the usability of the cured leaves for the specific products [1]. It has been known for more than twenty years that a wide scope of tobacco contains radioactive  $^{210}\text{Pb}$  which emits negative beta particles and radioactive  $^{210}\text{Po}$  which emits alpha particles. Soil contains radioactive elements that could be due to phosphate ore which is used as a fertilizer in tobacco fields and  $^{210}\text{Pb}$ . [2]. Thus the current work is concerned with the determination of the  $^{222}\text{Rn}$  concentrations ( $C_{\text{Rn}}$ ) and the radon surface exhalation rates in some cigarettes tobacco samples accessible in the local Iraqi markets.

### 1- Materials and Method

Twelve cigarettes samples of various brands were gathered from local Iraqi markets. The samples were grinded and sifted with special sieve of a grain size of approximately  $650\mu\text{m}$ . The samples were weighted to about (ten g) (approximately 25 cigarettes) and placed in a cylindrical plastic cup. Figure 1 shows the dimensions of this plastic cylinder. Pieces of ( $1\text{cm}^2$ ) CR-39 track detector were fixed in the top cover of the plastic cylinder. The detectors will be exposed to  $^{222}\text{Rn}$  produced from the samples for 45 days, so as to measure the radioactivity from the samples.



**Figure 1-**  $^{222}\text{Rn}$  estimation utilizing (CR-39) detector

After 45 days, the exposure time, the CR-39 detectors were etched in 6.25 N (Sodium hydroxide) at a temp. of  $65\text{ }^\circ\text{C}$  for six hour. The tracks density were recorded utilizing an optical microscope with (400x) magnification. The tracks density ( $\rho$ ) determined according to the relation [3]:

$$\text{Track density } (\rho) = \frac{\text{Average number of total pits (tracks)}}{\text{Area of field view}} \quad \dots\dots (1)$$

The <sup>222</sup>Rn concentration (C<sub>Rn</sub>) in the studied cigarettes tobacco samples were obtained utilizing the usual method,i.e. ,by the comparison between (ρ) registered by the detectors of the samples and that of the standard cigarettes tobacco samples [4] :

$$C_x = \rho_x \cdot (C_s / \rho_s) \quad \dots\dots (2)$$

**2- Determination of the <sup>222</sup>Rn exhalation rate (RER) in cigarettes tobacco samples**

The radon exhalation rate (RER) was calculated utilizing the relation [5]:

$$RER = \frac{C V \lambda}{A [T + \lambda^{-1}(e^{-\lambda T} - 1)]} \quad \dots\dots (3)$$

C: integrated radon exposure.

V: volume of air in the cylinder ,λ: decay constant for <sup>222</sup>Rn ,A : surface area of the sample , T : exposure time .

**3- Results and Discussion**

In the present work, the (C<sub>Rn</sub>) from cigarettes tobacco samples for 12 various cigarettes brands were measured utilizing CR-39 track detector. The outcomes of the measurements for C<sub>Rn</sub> in the studied tobacco samples which were collected from the local Iraqi markets are presented in Table 1 and demonstrated in Figure 2. The obtained data revealed that Macbeth sample, which is of Brazilian origin, recorded the highest C<sub>Rn</sub> with the value of (157 Bq/m<sup>3</sup>).. While, Sumer sample, which is an Iraqi cigarette brand, recorded the lowest C<sub>Rn</sub> with the value of (76.3 Bq/m<sup>3</sup>).The radon exhalation rate (RER) was found to be (4255.79 μBq/m<sup>2</sup>h)for the Macbeth sample, while that for Sumer sample was (8756.99 μBq/m<sup>2</sup>h). The scope of outcomes (76.3-157 Bq/m<sup>3</sup>) for C<sub>Rn</sub> in tobacco samples obtained in the present work, was found to be within the scope of outcomes (20.2-364 Bq/m<sup>3</sup>) given Ridha and Hasan [6] . The present average value of (106.53 Bq/m<sup>3</sup>) was obtained in this work.

**Table 1-Cigarettes brand, origin, mean of (C<sub>Rn</sub>) and (RER) for cigarettes tobacco samples .**

No.	Cigarette brand	Origin	Mean of C <sub>Rn</sub> (Bq/m <sup>3</sup> )	RER ( μ Bq.m <sup>-2</sup> .h <sup>-1</sup> )
1	Miami	UAE	89.8	5008.78
2	Arden	Britain	116.4	6492.44
3	Kent Silver	Britain	90.6	5053.40
4	Aspen	Germany	84.8	4729.89
5	Sumer	Iraq	76.3	4255.79
6	Davidoff	Germany	107.4	5990.45
7	Pine Silme	Korea	84.7	4724.31
8	Macbeth	Brazil	157	8756.99
9	Mikado	America	135.5	7557.78
10	Graven	Britain	144.6	8065.35
11	Oscar Silver	America	78.7	4389.65
12	Gold Seal	Germany	112.6	6280.49
<b>Average</b>			<b>106.53±22.3</b>	<b>5942.11</b>
<b>Max.</b>			<b>157</b>	<b>8756.99</b>
<b>Min.</b>			<b>76.3</b>	<b>4255.79</b>

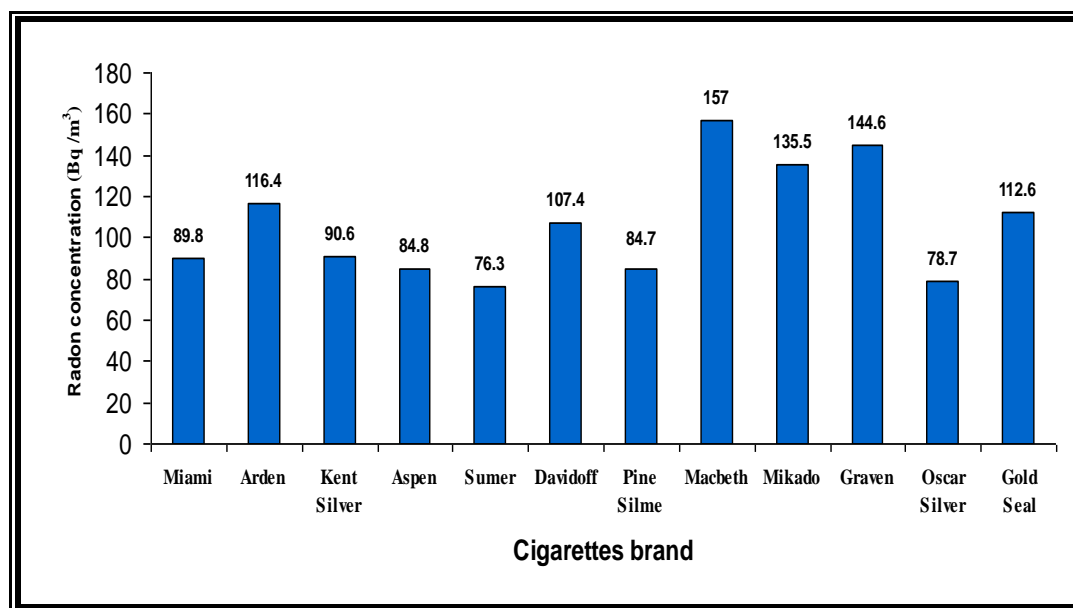


Figure 2- $C_{Rn}$  in the studied cigarettes tobacco samples.

#### 4- Conclusion

The present work have demonstrated that the  $C_{Rn}$  of the studied cigarettes tobacco samples were in the scope of (76.3-157 Bq/m<sup>3</sup>), with an average value of (106.53 Bq/m<sup>3</sup>) which is, in general, lower than the outcomes of some other similar studies given in the literatures. Nonetheless, it is well known that <sup>222</sup>Rn is the essential reason lung cancer, and for smokers the risk is higher, since it was previously observed a strong synergism between smoking and <sup>222</sup>Rn exposure.

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