

# Measurement of Radon Concentration in Hookah Flavor

Ali Nadhim Sabbar<sup>1,\*</sup>, Hayder Salah Naeem<sup>2,\*\*</sup>

<sup>1</sup>Physics Department, College of Sciences, Al-Muthana University, Iraq

<sup>2</sup>Physics Department, College of Basic Education, Al-Muthana University, Iraq

Emails: <sup>1</sup> [asabbar12@yahoo.com](mailto:asabbar12@yahoo.com), <sup>2</sup> [hs985@yahoo.com](mailto:hs985@yahoo.com)

**Abstract:** *In this work, we have measured the concentration of radon gas in samples of hookah flavor by using CR-39 nuclear track detector. To get the best results, these samples were dried by electric oven. Optical microscope (CM001 CYAN Scope) was used to count the number of tracks occurring on the detectors. The detectors were exposed to alpha particles emitted from the samples over a period of two months. NaOH - 6.25 N Solution was used to etch the detectors at 70 °C for 5 hours. The sealed-cup technique was used to measure the alpha particles emitted from the samples. The results obtained have proved the emission of Radon gas from hookah flavor, and shown different rates of concentration between 5.9 and 115 Bq/m<sup>3</sup>. The highest rate was in molasses Argelini / Melon honey dew flavor and the lowest rate in molasses Mazaya / Natural mint flavor.*

**Keywords:** Radon concentration, hookah flavor, molasses, sealed-cup technique, nuclear track detector, CR-39.

## 1. Introduction:

Radon (<sup>222</sup>Rn) is a radioactive noble gas results because the decay of radium (<sup>226</sup>Ra), an element of the <sup>238</sup>U decay series. Radon<sup>222</sup> decays into a series of other radioactive elements, that <sup>214</sup>Po and <sup>218</sup>Po are the most hazardous, as they contribute the most of radiation dose when inhaled. Radon-222 and its decay products are reported as main causes of lung cancer [1], [2].

Outdoor radon does not represent a significant health hazard because high concentrations are never reached. However, it becomes a problem when released into a closed or poorly ventilated enclosures like dwellings, buildings and also caves and mines. Indoor concentrations of radon and its short-lived progeny depend on several factors mainly related with the entry or production rate from various sources and the ventilation rate [3].

Indoor radon gas concentration is influenced by weather conditions (e.g. rainfall, wind speed and direction) and behavior of inhabitant [4].

Indoor radon concentrations for different locations depend upon the concentration of radioactive elements, uranium and radium in the soil, height of the dwelling and building material [5]-[7].

The emitted radiation from radioactive elements (radionuclides) can affect the whole body (by direct exposure) or affect tissues inside the body when inhaled or ingested. The health effects of alpha particles depend heavily upon how exposure takes place.

External exposure is of far less concern than internal exposure, because alpha particles cannot penetrate the outer dead layer of skin. However, if alpha emitters have been inhaled, ingested or absorbed into the blood stream, then living tissue will be directly exposed [8].

Smokers have the greatest risk of lung cancer. The risk of lung cancer increases with the length of smoking time and number of cigarettes. If they leave smoking for many years, they can reduce their chances of developing lung cancer [9].

According to the BEIR IV report of the US National Academies of Sciences, for men exposed to radon at work, smokers were **ten** times more likely to get lung cancer risk than non-smokers, and according to Pennsylvania Department of Environmental Protection smokers are approximately **six** times more likely to develop radon induced lung cancer than non-smokers. However, there are three primary factors that can increase the risk of developing lung cancer: the concentration of radon in the home, duration of exposure, and being a smoker [10], [11].

According to the EPA, radon is the second leading cause of lung cancer after smoking. Any radon exposure carries some risk - no level of radon is safe. The US EPA has set an action level of radon 4pCi/L. The average indoor radon level estimated to be 1.3pCi/L, and about of 0.4 pCi/L <sup>(1)</sup> is normally found in the outside air [12].

The aim of the present work is to test and evaluate the concentration of radon gas in hookah of different flavors available in Samawah city- Iraq.

$$^{(1)} 1 \text{ pCi/L} = 37 \text{ Bq/m}^3, 100 \text{ Bq/m}^3 = 2.7 \text{ pCi/L}$$

## 2. Experimental procedure:

Twenty one samples have been collected from market and dried by electric oven under 45 °C for 48 hrs. Samples of twenty grams were tested, placed in identical test flasks closed tidily with plastic covers.

Sheet of detector CR-39 of 1mm thickness was used, cut into square pieces (1cm x 1cm). One piece per flask pasted at the bottom of the plastic cover.

After 60 days irradiation time, the nuclear track detectors CR-39 was etched by 6.25N NaOH at 70 °C for 5hours.

An optical microscope type (CM001 CYANScope) with magnification of (SP4/0.10) was used to notice and count the number of tracks on each piece.

The concentration of radon gas  $C_{Rn}$  ( $Bq.cm^{-3}$ ) in hookah flavor samples was calculated by using the following relation [13]:

$$C_{Rn} = \rho / T K. \quad (1)$$

$$\rho = \text{Track/Area}, \quad (2)$$

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

where  $\rho$ : density of the tracks in the samples, T: exposure time and K:distribution system factor, it is given by relation (3) [14] :

### 3. Results and discussion:

Table (1) shows the data obtained for our samples:

Throughout the results, we have found that values of radon concentration of the samples used fluctuate between 115  $Bq/m^3$  corresponding to molasses Argelini - Melon honey dew flavor and 5.9  $Bq/m^3$  to molasses Mazaya-Natural mint flavor, both Jordanian products.

Compared with the recommended rang in 2014 by ICRP (100-300 $Bq/m^3$ ) our results show no hazard if the concentration of radon gas stays the same after burning hookah flavor what we could not confirm [15].

According to EPA estimation of indoor allowable level of radon gas concentration 1.3pCi/L (48.1 $Bq/m^3$ ) we already have four hookah flavors emitting over the normal level, which are: Argelini-Melon honey dew, Al fakher-mint flavor Nakhla molasses apple's flavor and Panorama-Molasses orange.

We still don't know the rate of concentration of radon emitted from hookah flavor after burning it; however, we expect it to be higher than what we measured. So by smoking tobacco with hookah flavor, the concentration of radon is expected to be even higher, which increases the risk of developing lung cancer. And finally smokers should beware of the dose accumulation over a long time smoking.

### 4. Conclusions

From the present work we found the following:

1. The highest rate of radon gas concentration was (115  $Bq/m^3$ ) in molasses Argelini / Melon honey dew flavor from Jordan.
2. The lowest rate of radon gas concentration was (5.9  $Bq/m^3$ ) in molasses Mazaya/ Natural strawberry flavor from Jordan.
3. According to the International Commission of Radiological Protection, the results we found are within the allowable limits if the concentration of radon gas does not increase during smoking hookah flavor, while according to the EPA we have already four hookah flavors emits radon over the normal level (as mentioned before), so hookah flavor adds risk of lung cancer to that due to tobacco for smokers.

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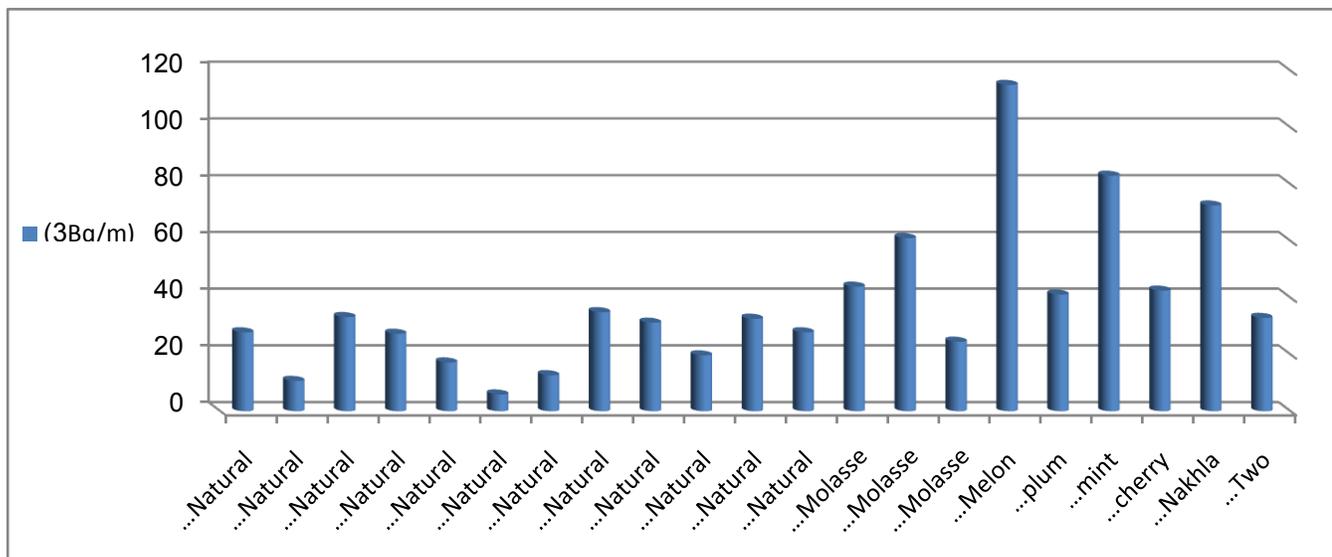
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**Table (1): Radon concentration of 21 samples for hookah flavors**

| №  | Country production | Molasses's Name | Flavor                              | Track density (Tr/cm <sup>2</sup> ) | Radon Concentration (Bq/m <sup>3</sup> ) |
|----|--------------------|-----------------|-------------------------------------|-------------------------------------|--|
| 1  | Jordan             | Mazaya          | Natural berry flavor                | 99                                  | 27.8                                     |
| 2  | Jordan             | Mazaya          | Natural strawberry flavor           | 38                                  | 10.7                                     |
| 3  | Jordan             | Mazaya          | Natural apple with mint flavor      | 118                                 | 33.2                                     |
| 4  | Jordan             | Mazaya          | Natural peach flavor                | 97                                  | 27.3                                     |
| 5  | Jordan             | Mazaya          | Natural gum flavor                  | 61                                  | 17.2                                     |
| 6  | Jordan             | Mazaya          | Natural mint flavor                 | 21                                  | 5.9                                      |
| 7  | Jordan             | Mazaya          | Natural watermelon with mint flavor | 45                                  | 12.7                                     |
| 8  | Jordan             | Mazaya          | Natural mastic gum flavor           | 124                                 | 34.9                                     |
| 9  | Jordan             | Mazaya          | Natural cool lemon flavor           | 111                                 | 31.2                                     |
| 10 | Jordan             | Mazaya          | Natural melon flavor                | 70                                  | 19.7                                     |
| 11 | Jordan             | Mazaya          | Natural orange flavor               | 116                                 | 32.6                                     |
| 12 | Jordan             | Mazaya          | Natural two apple flavor            | 99                                  | 27.8                                     |
| 13 | Jordan             | Panorama        | Molasses mint                       | 156                                 | 43.9                                     |
| 14 | Jordan             | Panorama        | Molasses orange                     | 217                                 | 61.0                                     |
| 15 | Jordan             | Panorama        | Molasses lemon                      | 87                                  | 24.5                                     |
| 16 | Jordan             | Argelini        | Melon honey dew                     | 409                                 | 115.0                                    |
| 17 | U.A.E              | Al fakher       | plum with mint flavor               | 146                                 | 41.1                                     |
| 18 | U.A.E              | Al fakher       | mint flavor                         | 295                                 | 83.0                                     |
| 19 | U.A.E              | Al fakher       | cherry with mint flavor             | 151                                 | 42.5                                     |
| 20 | Egypt              | Nakhla tobacco  | Nakhla molasses apple's flavor      | 258                                 | 72.5                                     |
| 21 | Egypt              | Nakhla tobacco  | Two apples flavor                   | 117                                 | 32.9                                     |

The following figure review the concentrations of Radon gas among different types of hookah flavors



**Fig.1 Radon gas concentration of hookah flavors**