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The effective radium content and radon exhalation rate in hair dyes samples

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► ***Original article***

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ABSTRACT

Background: Hair dyes are the important materials widely used by various peoples in Iraq and other countries. The present work investigates the presence of the effective radium content and radon exhalation rate in hair dyes samples. ***Materials and Methods:*** Twenty hair dyes samples were collected from Iraqi markets. Sealed can technique using LR-115 type II plastic track detector s has been used in order to measure the effective radium content and radon exhalation rate. ***Results:*** The average values of the effective radium content ranges were from 2.30±0.179 Bq/kg to 3.07±0.254Bq/kg and the average values of radon exhalation rate range of 0.282±0.019 mBq/m^2.day to 0.369±0.026 mBq/m^2.day. ***Conclusion:*** The results coincide with the recommended OECD and ICRP's action level. In addition a good correlation was found between the effective radium content and radon exhalation rate in hair dyes samples.

Keywords: *Hair dyes samples, Radon exhalation rate, effective radium content, Sealed can technique, LR- 115 type II.*

INTRODUCTION

It is well known that the living organisms are continuously exposed to naturally existed ionizing radiation. The radiation sources include cosmic rays, terrestrial radionuclides in the Earth's crust, water and foods as well as those that normally exist in the human body itself [(1)]. The natural radiation, generally, resulted from the distribution of radionuclides on earth. This in turn cause living organisms to be exposed to radiation risk [(2)]. In this context, uranium is the fundamental source of radium and radon in the soil and rocks. The radioactive radium is solid under allowable conditions of temperature and pressure. It decays to radon giving off α-particles followed by gamma rays. The radium's concentration is responsible for that how many atoms of radon are generated. The number of radon atoms emitted from the mineral grains or matter and then entered via the pore spaces depends on; the presence of radium atoms in the grain, the texture, the permeability, temperature and pressure [(3-6)]. Radon concentrations and radium isotope may be exist by different natural material such as soil, plant and other material. The radon may be transferred into human beings by the way of internal or external exposure. Therefore, it motivates us to estimate the radon exhalation rate and the effective radium content in hair dyes samples of common use which collected from the local market. This work is also essential from the viewpoints of health and environmental problems. Hair dyes are cosmetics that are put in contact with the skin. It is containing chemical products which may be risky for health. To ensure that hair dyes contain only safe substances, the European Commission has restricted the use of hair dyes to around 45 chemicals [(7)]. There are many publication have used solid state nuclear track detector to measure natural radioactivity in different materials such as building material, detergent powders, toothpastes and other [(8-11)]. This study aims to identify the action of radionuclides from the natural such as radon

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exhalation rate and the effective radium content in some samples hair dyes from different countries that are available in the Iraqi markets using solid state nuclear track detector (LR-115 Type 2).

MATERIALS AND METHODS

The radon exhalation rate in terms of mass (E_{m}-) and the effective radium content (C_{Ra}) were identified by LR-115 type 2 detectors' passive technique. Twenty samples of hair dyes were taken from several markets in Iraq (table 1). The collection of samples was performed between January 2015 and June 2015.

LR-115 Type-II detectors were placed at the closed top end of a plastic cup (diameter 5 cm and length 9 cm) as shown in figure 2. The thickness of the used SSNTDs was 12 mm LR-115 type-II strippable cellulose nitrate films, reinforced on a transparent 100 mm polyester thickness (cellulose acetate) sheet, by the French Kodak Path. Sufficient quantities of hair dyes samples were collected for measuring of radon concentrations. The exposure was completed in each sample within a period of about 60 day. After exposure, the detectors were removed from the dosimeters and etched in 2.5 N NaOH solution at 60 °C for 1.5 h in a bath with water of constant temperature to reveal the tracks. The tracks recorded on LR-115 detectors were counted using an optical microscope (NOVEL, China) of 40× magnification power with USB 2.0 Camera Application V 2.3 software. Background track density of an unexposed detector has also been counted. The changed track density was at that point earned by deducting the track number on a detector that's unexposed from the exposed one within the current calibration experimentation wanted to confirm ^{222}Rn gas concentration originating from a ^{226}Ra source with 3.3 kBq.

Table 1. Samples investigated in this study.

No.	Sample Code	Sample Brand	Made Produce
1	S1	Lady	Iran
2	S2	Majesty	Thailand
3	S3	Lana (For Man)	China
4	S4	White Sea	China
5	S5	Garnier	Poland
6	S6	Juxiu (For Man)	China
7	S7	Xclusive	China
8	S8	Mycolor	Italy
9	S9	Valancy	France
10	S10	Koleston	Labnan
11	S11	Palette	Germany
12	S12	Diva	Turkey
13	S13	Vita color	Italy
14	S14	Beauty	EU
15	S15	Lana	China
16	S16	Waves	Syria
17	S17	Jk (For Man)	China
18	S18	Peacock	China
19	S19	Bigen	Japan
20	S20	Vatika	India

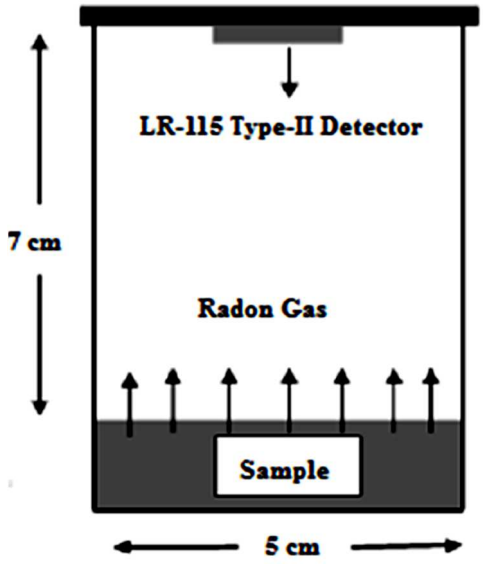


Figure 1. A test tube technique used in the study.

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Calculation of the radon exhalation rate and the effective radium content

The track densities (ρ) can be measured using the equation (1) [12]:

$$\rho = \frac{\sum_i N_i}{nA} \dots\dots\dots\dots\dots\dots (1)$$

where, A is the area of the field of view, N_i is the total number of tracks and n is the total number of fields of views.

While, the radon concentration (C_{Rn}) was calculated by equation (2) [13]:

$$C_{Rn}\left(\frac{Bq}{m^3}\right) = \frac{N_o\, t_o \rho}{\rho_o\, t} \dots\dots\dots\dots\dots\dots (2)$$

where, N_o, t_o and ρ_o are the activity concentration, the exposure time and the track density for a standard source (Ra-226) respectively, while t and ρ are the exposure time and the track density for hair dyes samples under study.

The effective radium content of the hair dyes samples are often calculated by equation (3) [14-15]:

$$C_{Ra}\left(\frac{Bq}{kg}\right) = \left(\frac{\rho}{k\, T_e}\right)\left(\frac{h\, A}{M}\right) \dots\dots\dots\dots\dots\dots (3)$$

where, h is the distance between the detector and the sample, A is the area of a cross section of the cylinder, M is the mass of the hair dyes sample, K is the calibration factor of LR-115 type II detector. It is measured by standard source (Ra-226) which is equal to (0.0217 Track.cm^{-2}/ Bq.m^{-3}.day) and T_e the effective exposure time.

The effective exposure time (T_e) and the exhalation rate in term of mass (E_M) were calculated by equations (4) and (5) respectively [15,16]:

$$T_e = T - \frac{1}{\lambda\,(1-e^{-\lambda T})} \qquad (4)$$

where, V is the volume of the radon chamber and λ is the decay constant for Rn-222.

$$E_M\left(\frac{mBq}{m^2 d}\right) = \frac{C_{Rn}\, V\, \lambda}{M\,[T + 1/\lambda(e^{-\lambda t} - 1)]} \dots\dots\dots\dots\dots\dots (5)$$

RESULTS AND DISCUSSION

Table 2 shows the minimum, maximum and average values of effective radium content of twenty samples of hair dyes from various countries. Table 2 shows that, the average of effective radium content in hair dyes samples varies from (2.30±0.179) Bq/kg to (3.07±0.254) Bq/kg (Total average is 2.71±0.218 Bq/kg). The higher value of effective radium content relatively has been observed in sample S7 (Xclusive, made in china), which denoted the lower than permissible value of 370 Bq/kg [17].

The minimum, maximum and average values of radon exhalation Rate in the studied of hair dyes samples are given in table 3. From table 3, it can be seen that the average rate of the radon exhalation varied from (0.282±0.019) Bq/ m^2.day to (0.369±0.026) Bq/m^2.day (total average is 0.331±0.023 Bq/m^2.day). To detect connection between the radon exhalation rate and effective radium content, figure 2 shows a graph and detected the correlation coefficient. A good correlation coefficient (R^2= 0.75) has been found between the radon exhalation rate and effective radium content. The effective radium content and radon exhalation rate in the hair dyes samples were low and not significant from the point of view on health hazard.

CONCLUSION

The effective radium content and the radon exhalation concentration rate have been studied in twenty samples of dye hair that were collected from local Iraqi markets. The highest value of effective radium content was detected in S7 sample, while the lowest value was found in S11 sample. Also, the highest value of exhalation rate was detected in S9 sample while the lowest value was found in S4 sample. The results of this study clearly indicate that the effective radium content and the radon exhalation concentration rate in used samples in present study are mostly below the permissible values limits.

Conflicts of interest: *Declared none.*

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Table 2. The results of effective radium in hair dyes samples.

No.	Sample code	Effective Radium Content (Bq/kg)		
		Minimum	Maximum	Average
1	S1	1.93	3.46	2.79
2	S2	2.44	3.94	3.17
3	S3	2.57	2.8	2.64
4	S4	0.93	1.03	0.98
5	S5	3.86	4.87	4.40
6	S6	3.4	4.94	4.22
7	S7	3.6	5.26	4.45
8	S8	3.13	4.00	3.75
9	S9	2.87	3.73	3.38
10	S10	1.73	2.87	2.43
11	S11	1.10	1.66	1.32
12	S12	1.52	1.8	1.64
13	S13	2.63	2.91	2.77
14	S14	2.08	2.49	2.23
15	S15	2.01	2.49	2.33
16	S16	2.35	2.77	2.57
17	S17	1.6	2.87	2.23
18	S18	2.01	2.54	2.29
19	S19	2.08	2.42	2.24
20	S20	2.21	2.63	2.39
Average±SD		**2.30±0.179**	**3.07±0.254**	**2.71±0.218**

Table 3. Shows the results of radon exhalation rate in hair dyes samples.

No.	Sample code	Radon Exhalation Rate (mBq/m^2.day)		
		Minimum	Maximum	Average
1	S1	0.199	0.265	0.287
2	S2	0.281	0.454	0.365
3	S3	0.301	0.336	0.317
4	S4	0.128	0.144	0.134
5	S5	0.412	0.52	0.469
6	S6	0.364	0.527	0.451
7	S7	0.384	0.561	0.474
8	S8	0.311	0.404	0.372
9	S9	0.435	0.567	0.5135
10	S10	0.237	0.394	0.334
11	S11	0.133	0.199	0.159
12	S12	0.209	0.247	0.225
13	S13	0.27	0.300	0.285
14	S14	0.285	0.342	0.307
15	S15	0.263	0.326	0.305
16	S16	0.282	0.332	0.308
17	S17	0.153	0.275	0.214
18	S18	0.322	0.407	0.366
19	S19	0.316	0.367	0.341
20	S20	0.354	0.421	0.383
Average±SD		**0.282±0.019**	**0.369±0.026**	**0.331±0.023**

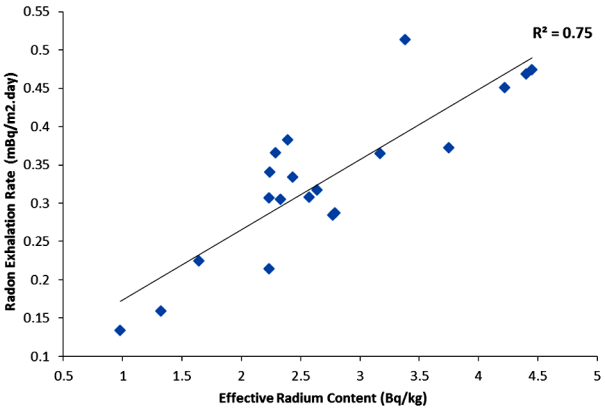


Figure 2. Correlation between the effective radium content and radon exhalation Rate in samples under study.

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