RADON CONCENTRATIONS IN HENNA (*LAWSONIA INERMIS*) LEAF SAMPLES COLLECTED FROM BASRAH, IRAQ

by

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Scientific paper
http://doi.org/10.2298/NTRP181215030A

Henna leaves are a priority material for hair dyes and body tattoos and have been used for this purpose for decades. In Iraq, henna is used widely but it requires substantial controls. Iraq is considered an environmentally polluted area as a result of the wars it has experienced, hence, this study has been conducted to calculate the level of ^{222}Rn contamination in henna leaves using a CR-39 nuclear track detector. The leaves were collected from the province of Basrah, which is located in southern Iraq and is famous for cultivation of this plant. The radon concentrations were found to range from 12.140 to 16.255 Bqm^{-3} in Al-Faw, and from 7.613 to 11.111 Bqm^{-3} in Abu Al Khasib. Radon activity ranged from 6.09 10^{-4} to 8.16 10^{-4} Bq in Al-Faw, whereas, in Abu Al Khasib it ranged from 3.82 10^{-4} to 5.58 10^{-4} Bq. Radon specific activity ranged from 1.22 10^{-4} to 1.63 10^{-4} Bqg^{-1} in Al-Faw, and from 7.64 10^{-5} to 1.12 10^{-4} Bqg^{-1} in Abu Al Khasib. The radon exhalation rate ranged from 4.05 10^{-4} to 5.43 10^{-4} with an average of 4.69 10^{-4} Bqm^{-2}d^{-1} in Al-Faw, and from 2.54 10^{-4} to 3.71 10^{-4} with an average of 3.22 10^{-4} Bqm^{-2}d^{-1} in Abu Al Khasib. After obtaining the results, one can conclude that the henna plant collected from these areas is safe for human use and is free from high rates of ^{222}Rn.

Key words: henna, Iraq, CR-39 detector, radon concentration, radioactivity

INTRODUCTION

Studies have been conducted in the southern regions of Iraq to measure the radioactive contamination in the soil of some provinces of the Basrah governorate. An elevated radioactive contamination in the soil has been recorded in [1]. Al-Faw and Abu Al Khasib are districts in Basrah that are famous for the spread of henna trees. In Basra, there are hundreds of cancer patients, most of who have been diagnosed late, either because of the ignorance of the patient or their failure to have regular health check-ups. Environmentalists have confirmed the spread of *dangerous radioactive contamination* caused by depleted uranium after bringing parts of armored vehicles that participated in the wars into cities [2]. The military vehicles and equipment were transferred to the districts in different regions of Basrah, such as Abu Al Khasib, Al-Faw, Qurnah, Deir, Zubayr, and Hayia, where the sale of scrap iron and the remnants of military vehicles is present [3]. The radionuclides that exist in the environment are transmitted onto plant parts via: uptake from soil by roots and their absorption via aerial parts of the plants [4], and are then ingested as food by humans or animals. In addition to the benefits of plants as food there are other advantages as there are some types of plants that are used as hair dyes or as tattoo work on the body, as well as being used as a natural treatment for some diseases. The henna (*Lawsonia inermis*) tree (the name henna originates from the Arabic word hinna) is a flowering tree, consisting of roots, bark, leaves, flowers, and fruits [5]. The plant is extremely branched, and attains a height of 2-7.5 m [6]. Henna trees belong to the *Lythraceae* family and have been used for the coloring of the skin and hair as well as in medicine. They are present as a paste, and powder which is obtained from its leaves as a sort of cosmetic [7]. Henna dye is made by collecting henna leaves from the trees, drying them and then grinding them into a powder that is mixed with a little water which becomes a thick glue dye that is placed on the hair or on some parts of the body as a tattoo, or as a treatment for some skin diseases. When henna dye is placed on the hair it needs hours to dry, and if the henna used is contaminated with high radiation rates, its long presence on the body may pose risks to human health. Henna has been used as a hair dye for thousands of years (4000 B.C.) in Egypt [8], and it has lasted throughout the centuries in many countries, particularly in the Middle East (such as

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Iraq), Canada, Australia, United States, and Europe, and each country has its own production using several types according to its tradition [9, 10]. In Iraq, henna leaves are collected from trees, processed, placed in bags and then sold in local markets and are often purchased by women to be used as a hair dye or to make various body tattoos. The collection and processing of henna in Iraq is not controlled, and thus the amount of radioactive contamination is not measured to estimate whether the herb is suitable for human use, however the estimation of radioactivity in hair dyes is essential [11].

Radon is deemed as the principal exposure source (about 55 %) to human beings due to its emission of alpha particles and is considered as the main source of cancer after smoking [12, 13]. Radon has a half-life of 3.82 days and it is a product of the decay of ^{226}Ra that is naturally emitted from soil and rocks [14]. Radionuclides can be transferred to plants, this transfer has been estimated by various researchers in order to evaluate the presence of radioactivity in plant organs [15-17] and also through the estimation of the transfer factor that predicts the value of radionuclides that enter the plant from the soil [18]. Placing the plant glue directly on the skin, which may contain scratches and wounds, can cause the transmission of radionuclides onto the human body, which is prone to cancer.

The aim of this study is to estimate the radon concentrations, activity, specific activity, and radon exhalation rate in henna plants grown in the Abu Al Khasib and Al-Faw districts in the Basrah governorate in southern Iraq using a CR-39 solid state nuclear track detector to determine the radioactive contamination in that plant, which is widely used in Iraq by women primarily as a hair dye or for tattoos, and as a skin disease treatment.

MATERIALS AND METHODS

Eighteen henna leaf samples were collected during the summer of 2017 from the Abu Al Khasiband and Al-Faw districts in Basrah, southern Iraq. The locations of the sampling site were indicated on the map as yellow and blue circles to distinguish the collection site, fig. 1. The leaves were air dried for one week, crushed, sieved, and weighted as 5 g for each sample.

The CR-39 nuclear track detectors are highly sensitive to α-particles and are widely used for environmental radon and its progeny detection, with 100 % detection efficiency supplied so that the particles emit sufficient energy as they interact with it [19]. The CR-39 detectors of (500 m) thickness, and density of 1.36 gcm^{-3} were cut into small pieces with a 1 cm × 1 cm area and fixed inside a plastic container as shown in fig. 2. Henna samples that have a volume of

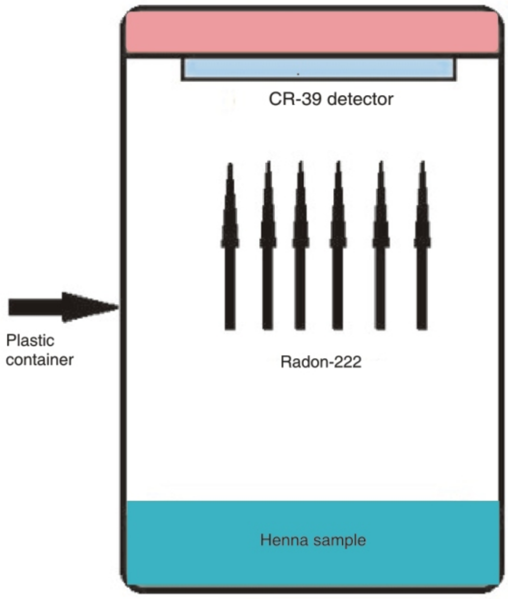

Figure 2. A schematic diagram of the sealed-cup technique

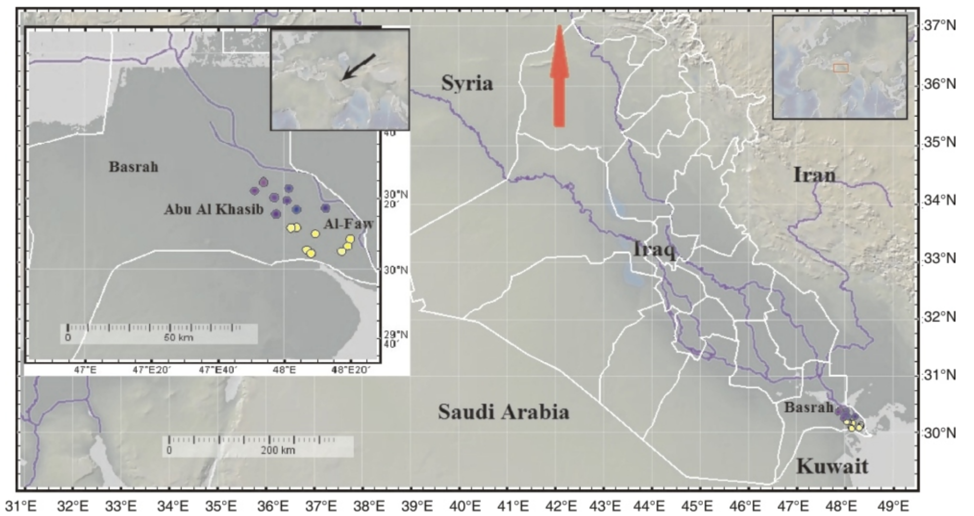

Figure 1. Map of Iraq including the sampling sites conducted using GeoMapApp

Figure 3. A magnified 1 mm × 1 mm image showing the alpha tracks that appeared on the CR-39 detector after 60 days of exposure

$5.02\ 10^{-6}$ m^3 were located in the container that was covered tightly to make sure there were no outlets for alpha particles and were exposed for 60 days.

After 60 days, the detectors were etched for 6.30 hours in 6.25 *N* NaOH solutions at 60 °C in the laboratory. The detectors were washed with distilled water, dried, and scanned using an optical microscope at 400x magnification to count the number of alpha tracks per mm^2 registered on the plastic detectors, fig. 3.

The density of the tracks, ρ, in CR-39 detectors was obtained according to the following relation [20, 21]

$$\text{track density} \quad \frac{\text{average number of total tracks}}{\text{area of field view}} \tag{1}$$

The radon concentrations were measured using the relation [20]

$$\frac{C_x}{\rho_x} \quad \frac{C_s}{\rho_s} \tag{2}$$

where C_s and C_x are the radon contents for standard and unknown samples, respectively.

The ρ_s and ρ_x are the track density for the standard and unknown samples, respectively.

The relation between the track density in tracks per mm^2 and radon concentration for the standard sample in Bqm^{-3} is shown in fig. 4.

Based on the obtained data for the radon concentration C_{Rn}, the value of radon activity A_{Rn} and specific radon activity SA_{Rn} can be estimated using the following expressions [22, 23],

$$A_{Rn} \quad C_{Rn}V \tag{3}$$

$$SA_{Rn} \quad \frac{A_{Rn}}{m} \tag{4}$$

where V is the volume of the sample and m – the mass of the sample.

The following expression gives the radon exhalation rate [24-26]

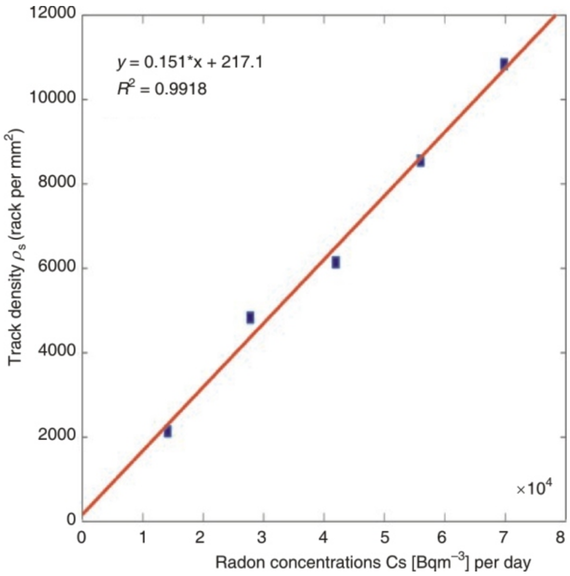

Figure 4. The relation between the track density and radon concentrations in a standard sample

$$E_x \quad \frac{C_{Rn}V\lambda}{A\ T + \frac{1}{\lambda}\{e^{\lambda T} \quad 1\}} \tag{5}$$

where E_x $[Bqm^{-2}d^{-1}]$ is the radon exhalation rate, C_{Rn} $[Bqm^{-3}d]$ – the radon activity, V $[m^3]$ – the volume of the sample, λ $[d^{-1}]$ – the radon decay constant, T [d] – the exposure time, and A $[m^2]$ – the area covered by the can.

RESULTS AND DISCUSSION

Radon can be transmitted onto plants by direct deposition onto leaf surfaces [27]. As the exposure of inhabitance to elevated concentrations of radon and its daughters for a prolonged time leads to some effects like respiratory functional changes that lead to lung cancer [28], the radon concentration in henna leaves has been measured. Values of the track density, ρ, radon concentrations, radon activity, A_{Rn}, radon specific activity, SA_{Rn}, and radon exhalation rates, E_x, in henna leaf samples collected from the Al-Faw and Abu Al Khasib districts in the Basrah governorate in southern Iraq are presented in tab. 1.

The radon concentrations in henna leaves were found to range from 12.14 Bqm^{-3} to 16.26 Bqm^{-3} with an average of 14.04 Bqm^{-3} in Al-Faw, and from 7.61 Bqm^{-3} to 11.11 Bqm^{-3} with an average of 9.65 Bqm^{-3} in Abu Al Khasib. The results show that the radon concentrations in Al-Faw are somewhat higher than Abu Al Khasib and they also varied a little bit from sample to sample but were found to satisfy the safety criteria recommended by the ICRP (200-600 Bqm^{-3}) [29] and do not pose a health hazard. This slight variation in values may be due to the type of phosphate fertilizer used in the cultivation of henna trees which is transferred onto the leaves of the plant.

Table 1. Radon track density, concentration, activity, specific activity, and radon exhalation rates in henna leaves collected from Al-Faw and Abu Al Khasib with its minimum (min.), maximum (max.), average (ave.), standard diviation (stdev.), and median (med.) values

Sample number	ρ (Tracks per mm^2)	C_{Rn} [Bqm^{-3}]	A_{Rn} [Bq]	SA_{Rn} [Bqg^{-1}]	E_x (Bqm^{-2}d^{-1}]
Al-Faw					
1	127.78	14.20	7.13 10^{-4}	1.43 10^{-4}	4.74 10^{-4}
2	137.04	15.23	7.65 10^{-4}	1.53 10^{-4}	5.09 10^{-4}
3	112.96	12.55	6.30 10^{-4}	1.26 10^{-4}	4.19 10^{-4}
4	138.89	15.43	7.75 10^{-4}	1.55 10^{-4}	5.15 10^{-4}
5	112.96	12.55	6.30 10^{-4}	1.26 10^{-4}	4.19 10^{-4}
6	146.30	16.26	8.16 10^{-4}	1.63 10^{-4}	5.43 10^{-4}
7	109.26	12.14	6.09 10^{-4}	1.22 10^{-4}	4.05 10^{-4}
8	125.93	13.99	7.02 10^{-4}	1.40 10^{-4}	4.67 10^{-4}
Ave.		14.04	7.05 10^{-4}	1.41 10^{-4}	4.69 10^{-4}
Min.		12.14	6.09 10^{-4}	1.22 10^{-4}	4.05 10^{-4}
Max.		16.26	8.16 10^{-4}	1.63 10^{-4}	5.43 10^{-4}
Stdev.		1.53	7.67 10^{-5}	1.53 10^{-4}	5.10 10^{-5}
Med.		14.10	7.08 10^{-4}	1.42 10^{-4}	4.71 10^{-4}
Abu Al Khasib					
9	88.89	9.88	4.96 10^{-4}	9.92 10^{-5}	3.30 10^{-4}
10	74.07	8.23	4.13 10^{-4}	8.26 10^{-5}	2.75 10^{-4}
11	100	11.11	5.58 10^{-4}	1.12 10^{-4}	3.71 10^{-4}
12	88.89	9.88	4.96 10^{-4}	9.92 10^{-5}	3.30 10^{-4}
13	83.33	9.26	4.65 10^{-4}	9.30 10^{-5}	3.09 10^{-4}
14	68.52	7.61	3.82 10^{-4}	7.64 10^{-5}	2.54 10^{-4}
15	96.30	10.70	5.37 10^{-4}	1.07 10^{-4}	3.57 10^{-4}
16	94.44	10.49	5.27 10^{-4}	1.05 10^{-4}	3.50 10^{-4}
Ave.		9.65	4.84 10^{-4}	9.68 10^{-5}	3.22 10^{-4}
Min.		7.61	3.82 10^{-4}	7.64 10^{-5}	2.54$10^{-4}$
Max.		11.11	5.58 10^{-4}	1.12 10^{-4}	3.71 10^{-4}
Stdev.		1.22	6.11 10^{-5}	1.22 10^{-5}	4.06 10^{-5}
Med.		9.88	4.96 10^{-4}	9.92 10^{-5}	3.30 10^{-4}

As shown in tab. 1, the radon activities vary from 6.09 10^{-4} Bq to 8.16 10^{-4} Bq with an average of 7.05 10^{-4} Bq in Al-Faw, whereas, in Abu Al Khasib they range from 3.82 10^{-4} to 5.58 10^{-4} Bq with an average of 4.84 10^{-4} Bq. Radon specific activity varies from 1.22 10^{-4} Bqg^{-1} to 1.63 10^{-4} Bqg^{-1} and has an average of 1.41 10^{-4} Bqg^{-1} in Al-Faw, and ranges from 7.64 10^{-4} Bqg^{-1} to 1.12 10^{-4} Bqg^{-1} and has an average of 9.68 10^{-5} Bqg^{-1} in Abu Al Khasib. The small variation in the activity and specific activity between the two sites could be due to the uranium contamination difference in the two sites where the henna trees are grown, and/or water transmission. Additionally, it could be the result of the difference in the procedure of radionuclide transmission onto the leaves that were used as samples in the study.

The radon exhalation rate is of prime significance for the evaluation of the health radiation risk from henna leaves. According to tab. 1 the radon exhalation rates varies from 4.05 10^{-4} Bqm^{-2}d^{-1} to 5.43 10^{-4} Bqm^{-2}d^{-1} with an average of 4.69 10^{-4} Bqm^{-2}d^{-1} in Al-Faw, whereas, in Abu Al Khasib it ranges from 2.54 10^{-4} Bqm^{-2}d^{-1} to 3.71 10^{-4} Bqm^{-2}d^{-1} with an average of 3.22 10^{-4} Bqm^{-2}d^{-1}. In the present estimations, the radon exhalation rate does not show any significant influence on human health.

The mentioned results afore were calculated in samples with a mass of only 5 g that could be used in tattoos or for healing skin inflammation, on the other hand it was customary to use approximately one kilogram of crushed henna leaves after mixing them with water to be placed on the hair for the purpose of hair dyeing. For this reason, the radon concentrations will be different if this large amount of henna is used and the concentration will be approximately at an average of 2809 Bqm^{-3} in the Al-Faw henna, and with an average of 1929 Bqm^{-3} in the Abu Al Khasib henna. The accepted ^{222}Ra level established by the World Health Organization is 100 Bqm^{-3} [13]. These results do not pose a danger to the users of henna as a hair dye if it is applied approximately every two months and the henna leaves remain on the hair for a period not exceeding three hours, which is a short period.

CONCLUSION

After measuring the radon concentrations, activity, specific activity, and radon exhalation rate in henna plants grown in the Abu Al Khasib and Al-Faw districts in the Basrah governorate in southern Iraq, the results indicated that this plant is safe and has no significant effect on human health and can be used as cosmetic or medical treatment material. These results also indicated that the soil of the regions where the henna plants are planted is safe and is not affected by the contamination distributed in southern Iraq due to wars. The reason may be that the area is agricultural where vegetables and herbs are planted beside the trees, which has helped to purify the region and rid it of pollution.

AUTHORS' CONTRIBUTIONS

The idea for the research of radon concentrations in henna (Lawsonia inermis) leaf samples collected from Basrah, Iraq was suggested by R. S. Mohammed. Measurements were performed by R. S. Ahmed and R. S. Mohammed. The laboratory calibration of the radon concentrations in standard samples was conducted by A. A. Radhi, and the discussion of the results and writing of the article were performed by R. S. Ahmed.

REFERENCES

[1] Mohammed, R., Ahmed, R., Estimation of Excess Lifetime Cancer Risk and Radiation Hazard Indices in southern Iraq, *Environmental Earth Sciences, 76* (2017), 7, p. 303
[2] Al-Azzawi, S. N., Depleted Uranium Radioactive Contamination in Iraq: An overview, *Global research, 1* (2006), pp. 4-8
[3] Almuqdadi, K., Al-Ansari, N., The Waste of Wars in Iraq: Its Nature, Size and Contaminated Areas, in Landfills of Hazardous Waste and Its Implications on Health and Environment: 15/11/2011-17/11/2011. 2011
[4] Chauhan, P., Chauhan, R. P., Variation in Alpha Radioactivity of Plants with the Use of Different Fertilizers and Radon Measurement in Fertilized Soil Samples, *Journal of Environmental Health Science and Engineering, 12* (2014), 1, p. 70
[5] Udeani, N. A., Potential of Henna Leaves as Dye and Its Fastness Properties on Fabric, *World Academy of Science, Engineering and Technology, International Journal of Chemical, Molecular, Nuclear, Materials and Metallurgical Engineering, 9* (2015), 12, pp. 1459-1466
[6] Bailey, L. H., Bailey, E. Z., *Hortus Third: A Concise Dictionary of Plants Cultivated in the United States and Canada,* Macmillan, New York, USA, 1976
[7] Bhuvaneswari, K., *et al*., Inhibitory Concentrations of Lawsonia Inermis Dry Powder for Urinary Pathogens, *Indian Journal of Pharmacology, 34* (2002), 4, pp. 260-263
[8] Nohynek, G. J., *et al*., Toxicity and Human Health Risk of Hair Dyes, *Food and Chemical Toxicology, 42* (2004), 4, pp. 517-543
[9] Kortsch, C. B., *Dress Culture in Late Victorian Women's Fiction: Literacy, Textiles, and Activism*, Routledge, Abingdon, UK, 2016
[10] Westermarck, E., *Marriage Ceremonies in Morocco* (Routledge Revivals), Routledge, Abingdon, 2014
[11] Pietrzak-Flis, Z., *et al*., Daily Intakes of ^{238}U, ^{234}U, ^{232}Th, ^{230}Th, ^{228}Th, and ^{226}Ra in the Adult Population of Central Poland, *Science of the Total Environment, 273* (2001), 1-3, pp. 163-169
[12] ***, Radiation, U.N.S.C.o.t.E.o.A., Sources and Effects of Ionizing Radiation: Sources: United Nations Publications, 2000
[13] Ting, D. S. K., *WHO Handbook on Indoor Radon: A Public Health Perspective*, 2010, Taylor & Francis, Oxford, UK
[14] Kant, K., *et al*., Measurement of Inhalation Dose Due to Radon and Its Progeny in an Oil Refinery and Its Dwellings, *International Journal of Radiation Research, 1* (2004), 4, pp. 181-186
[15] Jibiri, N., *et al*., Activity Concentrations of ^{226}Ra, ^{228}Th, and ^{40}K in Different Food Crops from a high background radiation area in Bitsichi, Jos Plateau, Nigeria, *Radiation and Environmental Biophysics, 46* (2007), 1, pp. 53-59
[16] Medhat, M. E., *et al*., Determination of Lead and Radioactivity in Cosmetics Products: Hazard Assessment, *Nucl Technol Radiat, 30* (2015), 3, pp. 219-224
[17] Karatasli, M., Radionuclide and Heavy Metal Content in the Table Olive (Olea Europaea l.) from the Mediterranean Region of Turkey, *Nucl Technol Radiat, 33* (2018), 4, pp. 386-394
[18] Chen, S., *et al*., Soil to Plant Transfer of ^{238}U, ^{226}Ra, and ^{232}Th on a Uranium Mining-Impacted Soil from Southeastern China, *Journal of Environmental Radioactivity, 82* (2005), 2, pp. 223-236
[19] Jeong, T., *et al*., CR-39 Track Detector for Multi-MeV Ion Spectroscopy, *Scientific Reports, 7* (2017), 1, p. 2152
[20] Khan, H. A., Qureshi, A., Solid State Nuclear Track Detection: a Useful Geological/Geophysical Tool, *Nuclear Geophysics, 8* (1994), 1, pp. 1-37
[21] Bull, R., Durrani, S., *Solid State Nuclear Track Detectors, Principles, Method and Applications*, Pregamon Press, Oxford, UK, 1987
[22] Yousef, H. A., *et al*., Radon Exhalation Rate for Phosphate Rocks Samples Using Alpha Track Detectors, *Journal of Radiation Research and Applied Sciences, 9* (2016), 1, pp. 41-46
[23] Tykva, R., Sabol, J., *Low-Level Environmental Radioactivity: Sources and Evaluation*: CRC Press, Boka Raton, Fla., USA, 1995
[24] Abu-Jarad, F., *et al*., A Study of Radon Emitted from Building Materials Using Plastic α-Track Detectors, *Physics in Medicine & Biology, 25* (1980), 4, p. 683
[25] Khan, A., *et al*., Measurement of Radon Exhalation Rate from Some Building Materials, *International Journal of Radiation Applications and Instrumentation, Part D. Nuclear Tracks and Radiation Measurements, 20* (1992), 4, pp. 609-610
[26] Fleischer, R. L., *et al*., Mapping of Integrated Radon Emanation for Detection of Long-Distance Migration of Gases within the Earth: Techniques and Principles, *Journal of Geophysical Research: Solid Earth, 83* (1978), B7, pp. 3539-3549
[27] Oufni, L., *et al*., Determination of Radon and Thoron Concentrations in Different Parts of Some Plants Used in Traditional Medicine Using Nuclear Track Detectors, *American Journal of Environmental Protection, 1* (2013), 2, pp. 34-40
[28] Council, N. R., *Health Effects of Exposure to Radon: BEIR VI*: National Academies Press, 1999
[29] Brenner, D., *Protection Against Radon-222 at Home and at Work*, ICRP Publication, 65, Taylor & Francis, Oxford, UK, 1994

Received on December 15, 2018
Accepted on August 14, 2019

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КОНЦЕНТРАЦИЈА РАДОНА У УЗОРЦИМА ЛИШЋА КАНЕ (*LAWSONIA INERMIS*) ПРИКУПЉЕНИМ У БАСРИ У ИРАКУ

Лишће кане је главни материјал за израду боја за косу и тетоважу и у ту сврху се користи деценијама. У Ираку се кана широко употребљава али захтева знатну контроли. За Ирак се сматра да има загађену животну средину као последицу ратова, те је спроведена студија применом CR-39 нуклеарних траг детектора како би се израчунао ниво контаминације лишћа кане радоном (^{222}Rn). Лишће је сакупљено у провинцији Басра, која се налази у јужном делу Ирака и позната је по узгајању кане. Концентрација радона је измерена у опсегу од 12.140 до 16.255 Bqm^{-3} у Алфаву и у опсегу од 7.613 до 11.111 Bqm^{-3} у Абу Алкасибу. Активност радона била је у опсегу од 6.09 10^{-4} до 8.16 10^{-4} Bq у Алфаву, док је у Абу Алкасибу била у опсегу од 3.82 10^{-4} до 5.58 10^{-4} Bq. Специфична активност радона износила је 1.22 10^{-4} до 1.63 10 Bqg^{-1} у Алфаву и 7.64 10^{-5} до 1.12 10^{-4} Bqg^{-1} у Абу Алкасибу. Јачина ексхалације радона била је у опсегу од 4.05 10^{-1} до 5.43 10^{-4} са средњом вредношћу од 4.69 10^{-4} Bqm^{-2}d^{-1} у Алфаву, док је у Абу Алкасибу износила 2.54 10^{-4} до 3.71 10^{-4} са средњом вредношћу од 3.22 10^{-4} Bqm^{-2}d^{-1}. Након добијања резултата, може се сматрати да је кана која се добија из ових поднебља сигурна за људску употребу и да нема високих активности ^{222}Rn.

Кључне речи: кана, Ирак, CR-39 детектор, концентрација радона, радиоактивност