Estimation of Radon Concentration in Some Types of Charcoal Toothpastes Using CR-39 Track Detector

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Abstract

The amount of radioactivity of radon gas that is emitted from 10 toothpaste samples containing coal and available in the Iraqi markets was calculated, by using a CR-39 plastic organic detector. store of the samples with the CR-39 detector about time 3 month and the process of the etched by using 6.25 N of NaOH solution at temperature 85°C for 3 hours. The results showed the maximum value concentration of Radon (^{222}Rn) to be 103.4 $Bq.m^{-3}$ in Teeth Whitening- tooth powder and the minimum concentration of Radon (^{222}Rn) to be 15.75 in Crest- tooth paste . The mean value concentration of Radon (63.6293 $Bq.m^{-3}$). All the reading obtained are within the international range, (200 $Bq.m^{-3}$) as given by UNSCAR. There is no evidence of any health issues because the mean annual effective dose (1.605291 mSv/y) was below the range from 3 to 10 mSv/y according to reported of the ICRP (1993) .

1. Introduction

Man is part of nature. He is exposed to various factors that affect his health, including ionizing and non-ionizing radiation from natural and unnatural sources. It requires finding determinants that reduce exposure to radiation, are all sources of radiation [1]. Natural radiation was caused by the spread of radionuclides on the planet in general. As a result, live beings are exposed to the risk of radiation [2,14]. It is known that the most important natural radioactive sources are uranium, thorium and actinium, which are considered to generate radon gas. Under permissible temperature and pressure conditions, radioactive Radium Solidifies. It decomposes to Radon, which emits Gamma rays and Alpha-particles [15,16].

Radon concentrations and isotopes can be found in a variety of natural materials, including soil, plants, and other materials. The presence of radon gas in any substance has a health effect on humans, it is calculate the Radon exhalation rate and effective dose of the Radium concentration in the charcoal toothpaste samples collected from the market at the Iraq. The study is critical for the standpoints of health's human and environmental issues [17,18].

To maintain the teeth, daily use of toothpaste is required for all ages, and acts as an abrasive, assisting in the removal of dental plaque and food from the teeth, suppressing halitosis, and delivering active components (mostly Fluoride) to help prevent tooth and gum disease gingivitis [3,19,20]. The mechanical motion of the toothbrush, rather than the toothpaste, is responsible for the majority of the cleaning. Salt and Sodium Bicarbonate (Baking Soda) are two components that can be used to make a toothpaste alternative. Toothpaste is not meant to be ingested, however it is normally not dangerous if small amounts are mistakenly swallowed [21,22,23].

2. Experimental Part

Ten samples of various Charcoal toothpaste brands, accessible in the Iraqi local market and chosen based on how frequently they are used, were used in this investigation. those on the market that are listed in table (1).

Table 1. Charcoal toothpaste samples

No. sample	S.C	Name of Samples	manufacturing
1	S1	Cavity Protection-tooth paste	Australia
2	S2	DR. Rashel-tooth paste	P.R.C
3	S3	Charcoal-tooth paste	P.R.C
4	S4	Laser white-tooth paste(bamboo charcoal)	Thailand
5	S5	White Glo-tooth paste	Australia
6	S6	Colgate-tooth paste(natural extracts)	China
7	S7	Crest-tooth paste(black)	US
8	S8	Pasta Del Capitano-tooth paste	Italy
9	S9	Teeth Whitening-tooth powder	Iraq
10	S10	Laser white-tooth powder(black)	Thailand

The process of preparing charcoal toothpaste samples goes through several stages. First, drying

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using an oven at a temperature of 105C⁰, secondly, the grinding of sample by a mill for the purpose of homogenization of the sample after storage for one month.

Fig. 1 depicts a schematic diagram of the methods used for a long time to measure the amount of Radon in Charcoal toothpaste. Each plastic cup container measures 5 cm in height, 3.5 cm in diameter, and 2.5*2.5 cm^2 of CR-39 detector (from Track Analysis Systems Ltd., UK) that is attached to the bottom of the plastic cup using double-sided adhesive tape, sensitive side facing up. The samples were kept and left motionless in an ambient temperature, for 90 days after positioning the detectors and sealing the plastic cup properly. During this time, the equilibrium level between Radium and Radon is reached to about 98% [4,24]. The detectors were removed from the chambers after the exposure procedure was finished during the aforementioned time frame and prepped for the etching process and track viewing In order, to determind the tracks large enough to get the Alpha particle emitters from the Radon gase which is show the track on the surface of detectors, the chemical etching process ,the simplest and most widely used method for revealing the latent damage trails of ionizing particles in solids when Alpha particles are deposited in the body—was take the three hours [6], in (6.25) normality of NaOH at 85 °C. After halting the etching process and removing the impacts of solution etching, the detectors were rinsed in distilled water for twenty minutes. A microscope was then used to count the number of Alpha particle tracks by counting the density of the tracks created in the CR-39 reagent.

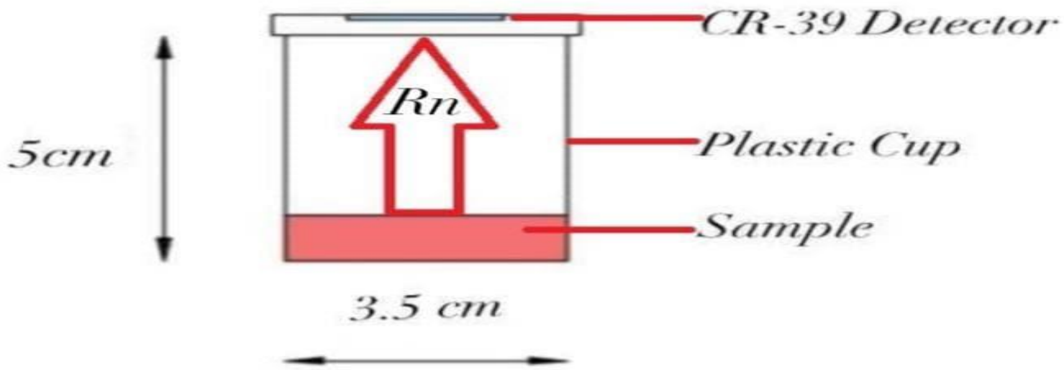

Figure 1. ^{222}Rn estimation by using CR-39 detector

Calculations

As previously indicated, the track (CR-39) detector technique is employed in this study to get the amount of Radon (α-particles) in samples of Charcoal toothpaste. This can be accomplished by documenting these particles trajectories on the surface CR-39 detector and in accordance with these relationships [7].

The track density (ρ), which is measured in track per square centimeter, is the first relationship. When Radon is emitted to samples of extracted charcoal toothpaste, it emits tracks of Radon particles, which are measured by density. Equ. is used to determine this word (1).

$$\rho\left(\frac{\text{Track}}{\text{cm}^2}\right) = \frac{\text{Number of Track}}{\text{Area of veiw}} \dots\dots\dots (1)$$

Equ. (2) can be used to specify activity ($\boldsymbol{C_{Rn}^{a}}$ Bq/m³) in Charcoal toothpastes samples [8,9].

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

Where t is exposing time sample, which is assumed to be 10 weeks (70 days), ρ is the track density expressed in Tr/cm² and *K* is the diffusion constant. In some writings, this constant is referred to as the sensitivity factor or the calibration factor [10,11].

It is important to note that equ. (3) can be used to calculate K value, which can be mathematically computed as follows [12,13]:

$$K = 0.25\, r\left(2cos\theta_c - \frac{r}{r_a}\right) \dots\dots\dots (3)$$

where the tube radius is 1.75 cm, the detector critical angle is 35°, and the Alpha particle range in air is assumed to be 4.15 cm [25, 26], yielding a theoretical K value of 0.5733 cm.

It's vital to clarify that the experimental K is measured in $Tr.cm^{-2}/Bq{\cdot}m^{-3}{\cdot}day$, whereas the K value has a unit of cm. Since (1Bq = Disintegration/sec. = tr./sec.), 1 day = 86,400 seconds, and $1m^3=10^6$ cm, it follows that 1 cm = $0.0864(Tr.cm^{-2}/Bq{\cdot}m^{-3}{\cdot}day)$ [27]. Therefore, $0.049Tr.cm^{-2}/Bq{\cdot}m^{-3}{\cdot}day$ serves as the diffusion constant for CR-39 detectors.

The annual effective dose (AED) attributable to Radon concentrations in samples was determined using the formulas found in [28,29].

$$AED\left(\frac{mSv}{y}\right) = C \times F \times H \times T \times D$$

Where H was the occupancy factor (0.8), F was represent the equilibrium factor (0.4), T was the year in hours (8760 h/y), and D was the dose conversion factor [9×10^{-6} (m Sv) / ($Bq.h.m^{-3}$)].

3. Result and Discussion

Ten samples of various charcoal toothpaste kinds were gathered, chosen based on their frequency of use, and the concentration of Radon was evaluated using the CR-39 detector. These samples are accessible in the local market in Iraq. Radon Concentration in toothpaste sample is shown in Table 2. Radon concentration is found to be between 15.75 to 103.4 Bq/m^{-3}, with a mean of 63.6293 Bq/m-

[3]. Crest toothpaste had the lowest value at 15.75 Bq/m^{-3}, whereas Pasta Del Charcoal toothpaste had the highest value of 103.4 Bq/m^{-3}. Table 2 shows the results of the maximum and minimum values of annual effective dose of radon gas in the study samples were found to be 2.608658mSv/y in S9 and 0.397354mSv/y in S7 respectively, and mean value of these result were 1.605291 mSv/y.

Table 2. Radon concentration for charcoal toothpaste samples.

S.C	Name of Samples	Radon concentration (Bq.m^{-3})	AED (mSv/y)
S1	Cavity Protection- tooth paste	49.06	1.237725
S2	DR.Rashel- tooth paste	87.33	2.203231
S3	Charcoal- tooth paste	45.56	1.149424
S4	Laser white – tooth paste	91.41	2.306165
S5	White Glo- tooth paste	62.503	1.576876
S6	Colgate- tooth paste	27.33	0.689503
S7	Crest- tooth paste	15.75	0.397354
S8	Pasta Del Capitano- tooth paste	56.7	1.430473
S9	Teeth Whitening- tooth powder	103.4	2.608658
S10	Laser white – tooth powder	97.25	2.453501

All the results are within the UNSCAR (United Nations Scientific Committee on the Effect of Atomic Radiation) data's international standards (200 Bq.m^{-3}) [5]. according to figure 2. Because the mean annual effective dosage (1.605291 mSv/y) was below the range (3-10 mSv/y) described by ICRP (1993) [30], there is no evidence of any health problems. according to figure 3.

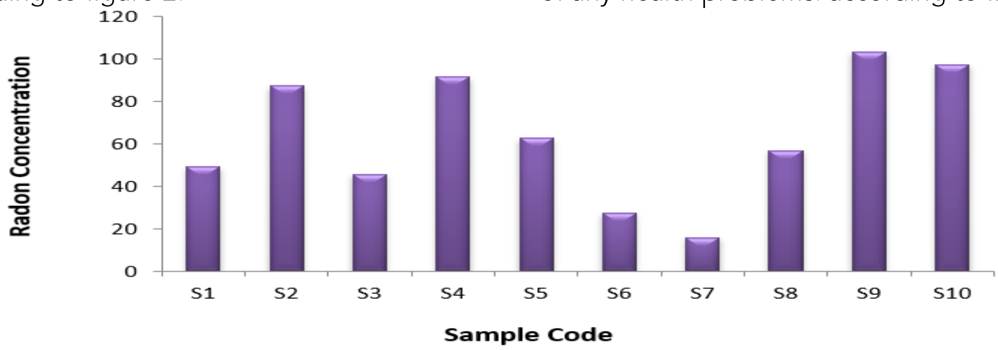

Figure 2. The concentration of Radon for toothpaste samples.

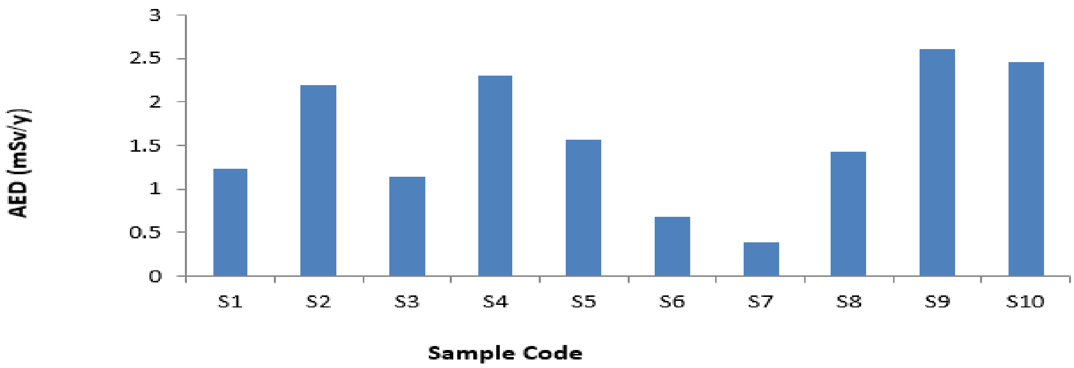

Figure 3. Annual effective dose for toothpaste samples.

4. Conclusion

These results showed that the maximum specific activity of radon in charcoal toothpaste samples was less than 200 Bq.m-3, which is the globally accepted limit for radon exposure [31,32].

The results showed a difference in the radon gas concentration values for the samples that were measured, due to the different sources of importing toothpaste. The need to monitor the product due to the daily use of toothpaste inside the mouth, and any dangerous substances used in the manufacture of the paste cause a danger to human health

Reference

Charles, M. (2001). UNSCEAR Report 2000: sources and effects of ionizing radiation. *Journal of Radiological Protection*, *21*(1), 83.

WHO (2005) Radon and cancer, fact sheet 291.

AboJassim, A. A., Kadhim, S. A., & Mohammed, F. A. (2014). Radon of concentrations measurement in some types of toothpastes available in the Iraqi markets. *Journal of Babylon University/Pure and Applied Sciences*, *22*(7), 1967-1972.

Durrani, S. A., & Bull, R. K. (2013). *Solid state nuclear track detection: principles, methods and applications* (Vol. 111). Elsevier.

United Nations Scientific Committee on the Effects of Atomic Radiation. (1993). Sources and effects of ionizing radiation: UNSCEAR 1993 report to the General Assembly. *New York, NY: United Nations*, 280-283.

Naji, T. F., &Hassoon, S. O. (2021, September). Measuring of Radon Gas Concentrations in serum

samples of Lung cancer patients in Babylon governorate, Iraq. In *Journal of Physics: Conference Series* (Vol. 1999, No. 1, p. 012054). IOP Publishing.
Karim M S, Mohammed A H and Abbas A A 2010. Measurement of Uranium Concentrations in Human Blood in Some the Regions of Baghdad Governorate Experimental Part The present study of uranium concentration in human blood from different. Ibn Al-Hait. Jour. For Pure And Appl. Scie. 23 , 25.
Aswood M Sh, Jaafar M S and Bauk S 2014 Measuring Radon Concentration Levels in Fertilizers Using CR-39 Detector. Adva. Mate. Res. 925, 610-614.
Narayan, Vipul, and A. K. Daniel. "Design consideration and issues in wireless sensor network deployment." (2020): 101-109.
Choudhary, Shubham, et al. "Fuzzy approach-based stable energy-efficient AODV routing protocol in mobile ad hoc networks." Software Defined Networking for Ad Hoc Networks. Cham: Springer International Publishing, 2022. 125-139.
Narayan, Vipul, and A. K. Daniel. "RBCHS: Region-based cluster head selection protocol in wireless sensor network." Proceedings of Integrated Intelligence Enable Networks and Computing: IIENC 2020. Springer Singapore, 2021.
Narayan, Vipul, and A. K. Daniel. "CHOP: Maximum coverage optimization and resolve hole healing problem using sleep and wake-up technique for WSN." ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal 11.2 (2022): 159-178.
Narayan, Vipul, and A. K. Daniel. "CHHP: coverage optimization and hole healing protocol using sleep and wake-up concept for wireless sensor network." International Journal of System Assurance Engineering and Management 13.Suppl 1 (2022): 546-556.
Narayan, Vipul, and A. K. Daniel. "IOT based sensor monitoring system for smart complex and shopping malls." Mobile Networks and Management: 11th EAI International Conference, MONAMI 2021, Virtual Event, October 27-29, 2021, Proceedings. Cham: Springer International Publishing, 2022.
Narayan, Vipul, and A. K. Daniel. "Energy Efficient Protocol for Lifetime Prediction of Wireless Sensor Network using Multivariate Polynomial Regression Model." Journal of Scientific & Industrial Research 81.12 (2022): 1297-1309.
Awasthi, Shashank, et al. "A Comparative Study of Various CAPTCHA Methods for Securing Web Pages." 2019 International Conference on Automation, Computational and Technology Management (ICACTM). IEEE, 2019.
Narayan, Vipul, and A. K. Daniel. "FBCHS: Fuzzy Based Cluster Head Selection Protocol to Enhance Network Lifetime of WSN." ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal 11.3 (2022): 285-307.
Narayan, Vipul, et al. "E-Commerce recommendation method based on collaborative filtering technology." International Journal of Current Engineering and Technology 7.3 (2017): 974-982.
Narayan, Vipul, et al. "To Implement a Web Page using Thread in Java." (2017).
Srivastava, Swapnita, and P. K. Singh. "HCIP: Hybrid Short Long History Table-based Cache Instruction Prefetcher." International Journal of Next-Generation Computing 13.3 (2022).
Srivastava, Swapnita, and P. K. Singh. "Proof of Optimality based on Greedy Algorithm for Offline Cache Replacement Algorithm." International Journal of Next-Generation Computing 13.3 (2022).
Smiti, Puja, Swapnita Srivastava, and Nitin Rakesh. "Video and audio streaming issues in multimedia application." 2018 8th International Conference on Cloud Computing, Data Science & Engineering (Confluence). IEEE, 2018.
Srivastava, Swapnita, and Shilpi Sharma. "Analysis of cyber related issues by implementing data mining Algorithm." 2019 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence). IEEE, 2019.
Narayan, Vipul, and A. K. Daniel. "Multi-tier cluster based smart farming using wireless sensor network." 2020 5th international conference on computing, communication and security (ICCCS). IEEE, 2020
Barillon, R., Klein, D., Chambaudet, A., &Devillard, C. (1993). Comparison of effectiveness of three radon detectors (LR115, CR39 and silicon diode pin) placed in a cylindrical device-theory and experimental techniques. Nuclear Tracks and Radiation Measurements, 22(1-4), 281-282.
Fleischer, R. L., &Mogro-Campero, A. (1978). 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*(B7), 3539-3549.
Ismail, A. H., &Jaafar, M. S. (2009). Experimental measurements on CR-39 response for radon gas and estimating the optimum dimensions of dosimeters for detection of radon. In *Proceedings of the 3rd Asian Physics Symposium, Bandung, Indonesia* (pp. 22-23).
Mohammad, A. I., & Al-Zubaidy, N. N. (2012). Estimation of natural radioactivity in water and soil in some villages of irbid city. *Applied physics research*, *4*(3), 39.
Khan, M. S., Srivastava, D. S., &Azam, A. (2012). Study of radium content and radon exhalation rates in soil samples of northern India. *Environmental Earth Sciences*, *67*(5), 1363-1371.
ICRP (International Commission on Radiological Protection) (1993) Protection against ^{222}Rn at home and work, publication. Ann ICRP 65:23–32 UNSCEAR-2008-Report , Vol.1-CORR. ICRP-105-106 (200)8