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# Radon Levels in different types of Plants with Medicinal Properties

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## Article Info

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## Abstract

In present study, natural levels of radon-222 in forty selected herbs with medicinal properties present in many stores throughout Iraq were measured to establish any potential radiation hazards. The Solid State Nuclear Track Detectors SSNTDs (CR-39) technique was used to determine these natural levels of radiation. The findings indicate that the radon concentrations ranged from 10.6602.07 Bq/m$^3$ to 53.3034.64 Bq/m$^3$ with an average 26.5373.21Bq/m$^3$. These radon concentration values were lower than those reported in literature. These results show that consumption of the studied plants would impose no health threat to the consumers.

**Keywords:** Herbs; Medicinal plants; Radon concentration; Nuclear track detector; CR-39.

## Introduction

Iraq has a long history and tradition of using herbs and other medicinal plants in traditional therapy which preceded the use of modern drugs and other antibiotics [1,2]. For thousands of years people have used and depended on herbs to treat many diseases. Presently, modern medicine and traditional or alternative medicine [3-5] are not exclusive, rather complementary to each another.

Radon-222 is a noble gas formed from radium ($^{226}$Ra) and has a half-life of 3.8 days. Radon-222 can be emitted from the earth, rocks, as well as construction materials, and it can accumulate with its short-lived progeny in the atmosphere within the residences [6]. Exposure and inhalation of $^{222}$Rn for a short time period may lead to lung cancer. As a result of natural radioactive decay in the soil radon isotope particles, $^{222}$Rn are released from the soil particles escaping into the atmosphere. The radon release rate from the soil is known as the radon emanation rate or the radon exhalation rate. Radon exhalation is an intricate phenomenon depending on a number of parameters such as soil morphology, radium content in the soil, temperature, atmospheric pressure, soil moisture, rainfall and soil particle size [7]. The Solid State Nuclear Track Detectors or SSNTD's are considered to be most used devices for radon concentration measurements in the ecological fields. They are widely used in detecting and measuring radioactivity in geological samples and studying the influence of pollution in the dwellings [8]. The CR – 39 plastic track detectors were used for the evaluation of radon concentration in different types of herbs used in this study.

## Materials and Methods

### Sample Collection and Preparation

In September of 2015, forty different samples of medicinal plants were collected from the local markets from various places in Najaf City, Iraq. Samples were classified into groups as shown in table 1. The cursor in front of each sample represents the sample code, trade name, scientific name, part used and country of origin. The samples were prepared by drying them for two to four days at the temperature from 42 to 44°C to eliminate absorbed moisture and obtain actual, dry weight. The dried samples were ground to a fine powder of equal size particles by using a blender. By using a highly sensitive scale with a tolerance ± 0.01%, we measured twenty grams of each individual sample for further analysis. Then the samples were placed in containers. Before use, containers were washed with dilute hydrochloric acid and rinsed with distilled water and assigned a code specific to each individual sample.

**Table 1.** List of herbs used in the study

| No | Sample code | Trade name | Scientific name | Part used | Origin |
|---|---|---|---|---|---|
| 1 | H1 | Senna | *Cassai senna L.* | Leaves | Saudi Arabia |
| 2 | H2 | Safflower | *Carthamus tinctorius* | Flowers | Iran |
| 3 | H3 | Ziziphus | *Ziziphus spina-Christi* L. | Leaves | Iraq |
| 4 | H4 | Hops | *Humulus lupulus* L. | Peduncle | Iran |
| 5 | H5 | Peppermint | *Mentha piperita* L. | Leaves | Iraq |
| 6 | H6 | Balanite | *Balanites aegyptica*(L.) Del. | Fruits | Egypt |
| 7 | H7 | Aelchenan | *Anabasis spp.* | Leaves | Iraq |
| 8 | H8 | Green tea | *Camellia sinensis* | Leaves | China |
| 9 | H9 | Fenugreek | *Trigonella foenum-graecum* L. | Seeds | India |
| 10 | H10 | Sweet marjoram | *Origanum majorana* | Aerial parts | Middle east |
| 11 | H11 | Ginger | *Zingiber officinale* | Roots | India |
| 12 | H12 | Greater plantain | *Plantago major* L. | Peel fruits &seeds | India |
| 13 | H13 | Hawthorn | *Crataegus spp.* | Leaves | USA |
| 14 | H14 | Chokecherry | *Prunus virginiana* L | Seeds | Azerbaijan |
| 15 | H15 | Myrtle | *Myrtus communis* L. | Leaves | Iraq |
| 16 | H16 | White cedar | *Thuja occidentalis* | Fruits | Syria |
| 17 | H17 | Rosemary | *Rosmarinus officinalis* L. | Aerial parts | Mediterra-nean sea |
| 18 | H18 | Chicory | *Cichorium intybus* L. | Roots, Stalk &leaves | Iraq |
| 19 | H19 | Chamomile | *Matricaria chamomilla* L. | Flowers | Syria |
| 20 | H20 | Sage | *Salvia officinalis* | Leaves | India |
| 21 | H21 | Maidenhair fern | *Adiantum capillus–veneris* L. | Leaves and Stalk | USA |
| 22 | H22 | Black mustard | *Brassica nigra*(L.) W.D.J. Koch | Seeds | China |
| 23 | H23 | Cyperus | *Cyperus esculentus* | Seeds | Egypt |
| 24 | H24 | Hollyhock | *Alcea rosea* L. | Flowers | India |
| 25 | H25 | Ginkgo | Ginkgo biloba. | Seeds | Iran |
| 26 | H26 | Bay leaves | *Laurus nobilis* | Leaves | Syria |
| 27 | H27 | Corn Mint or Bo He | *Mentha haplocalyx* | Aerial parts | India |
| 28 | H28 | Black cumin | *Nigella sativa* L. | Seeds | India |
| 29 | H29 | Roselle | *Hibiscus sabdariffa* L. | Flowers | Iraq |
| 30 | H30 | Horse tail | *Equisetium arvense* L. | Aerial parts | Egypt |
| 31 | H31 | African Rue | *Ruta chalepensis* L. | Aerial parts | Saudi Arabia |
| 32 | H32 | Flax | *Linum usitatissimum* L. | Seeds | Iran |
| 33 | H33 | Garden Angelica/ Stout bien | *Angelica archangelica* L. | Each herb | China |
| 34 | H34 | Yarrow | *Achillea millefolium* | Aerial parts | Iran |
| 35 | H35 | Nutgrass | *Cyperus rotundus* L. | Roots and leaves | Saudi Arabia |
| 36 | H36 | Colocynth | *Citrullus colocynthis* (L.) Shradc | Fruits | Iraq |
| 37 | H37 | Primrose | *Primula vulgaris* L. | Flowers | west Asia |
| 38 | H38 | Borage | *Borago officinales* | Flowers | Iran |
| 39 | H39 | Coltsfoot | *Tassilago farfara* | Leaves and flowers | North Asia |
| 40 | H40 | Rose of Jericho | *Anastatica hierochuntica* L. | Branches | Palestine |

**Laboratory Procedure**

Measurements were carried out upon 30 days after reaching the radiation equilibrium. Beacon covers were removed rapidly to prevent outside air from entering and changing the atmosphere in the cans. The nuclear detector CR-39 with dimensions of 1 cm$^2$ and 1 mm thick was placed at the middle of the underside of the cover and affixed with an adhesive tape. The edges of the cover were taped and sealed to prevent radon from leaking. The CR-39 detector recorded the presence and effects of alpha particles which resulted from the dissolution of radon gas. The distance between the surfaces of the sample and reagent was 5cm and the sample height was 2 cm as shown in figure 1. We applied the long-term method of 90 day exposure before removing the reagents exposing them to the chemical skimming procedure.

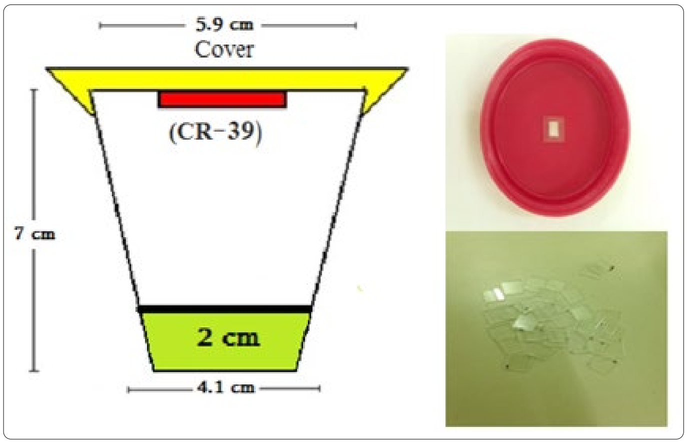


**Figure 1.** Schematic representation of the plastic container showing the position of the CR-39 detector and the sample tested.

**Chemical Etching and Microscopic Scanning**

Detectors were removed and etched in a 6.25N aqueous solution of NaOH. The detectors were placed inside Pyrex and linked with a wire. The Pyrex was placed inside a water bath. Following the standard protocol of keeping them in the bath at 70˚C for 7 hours, detectors were rinsed with distilled water and allowed to air-dry than placed in a plastic box [9].

The tracks recording the effect of alpha particles at the surface of the CR-39 nuclear detectors were observed by using novel optical microscope at 400x magnification as shown in figure 2. A total of five optic view fields were selected for taking the readings for each individual sample.

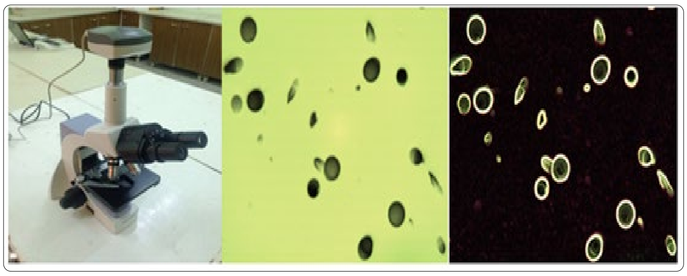

**Figure 2.** The effects of alpha particles chemical etching as seen at 400x by optical microscope.

**Calculation of Radon concentrations**

The density of the tracks ρ in the detectors was calculated according to the following equation [10].

$$\rho = \frac{N_{average}}{A} \ldots\ldots\ldots\ldots\ldots (1)$$

Where, $\rho$ is track density (Track /cm[2]), *N*is an average of total tracks (Track) and *A* is an area of a view field (cm[2]).

Radon concentration ($C_{Rn}$) in Bq/m[3] unit are calculated by the following equations [11,12].

$$C_{Rn} = \frac{\rho}{k\,T} \ldots\ldots\ldots\ldots\ldots (2)$$

Where, k : is the calibration factor in terms of (track.cm$^{-2}$/ Bq.d.m$^{-3}$) which is the same value as reported in many works [11-14]. T is the exposure time (d).

The value for radon activity ($A_{Rn}$) and specific radon activity ($S.A_{Rn}$) can be found based on radon concentrations, volume of container (V) and mass of a sample (m) as it follows: [8,15-17]

$$A_{Rn} = C_{Rn}\,V \ldots\ldots\ldots\ldots\ldots (3)$$

$$S.A_{Rn} = \frac{A_{Rn}}{m} \ldots\ldots\ldots\ldots\ldots (4)$$

# Results and Discussion

Table 2 presents radon concentration and specific activity for medicinal plant samples originated in different countries but obtained at the local markets. Our study shows that the lowest value of radon concentration was found in H6 Egypt sample, which was (10.6602.07 Bq/m[3]), while the highest average value was found in H35 Saudi Arabia sample, having values of (53.3034.64 Bq/m[3]) as shown in figure 3. The same sample from Saudi Arabia had shown specific radon activity. The specific radon activity varied from 0.003 ± 0.0003 Bq/kg in $H_2O$ samples to 0.7790.085 Bq/kg in H30 samples with an average 0.2830.035 Bq/kg. These results indicate that the reasons for variation of radon concentration in different medicinal plant samples are the result of chemical reaction by which radon transfer occurs from the soil solids into the water solution within the soil becoming absorbed by the roots and translocated throughout the plants. The uptake of these radio nuclides from the soil solution is controlled by plant physiology. Our findings are similar and very close to the reported results cited in the literature as presented in table 3.

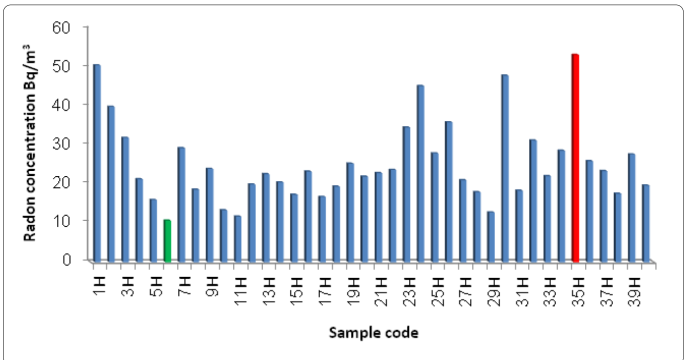


**Figure 3.** Radon concentration in medicinal plants.

**Table 2:** The radon concentration and specific radon activity in medicinal plants.

| Sample code | $C_{Rn}$ (Bq/m³) | $S.A_{Rn}$ (Bq/kg) |
|---|---|---|
| H1 | 50.6384.52 | 0.4700.042 |
| H2 | 39.9774.01 | 0.6490.085 |
| H3 | 31.9823.59 | 0.0310.277 |
| H4 | 21.3212.93 | 0.0290.213 |
| H5 | 15.9912.54 | 0.0300.188 |
| H6 | 10.6602.07 | 0.0080.046 |
| H7 | 29.3163.44 | 0.0230.200 |
| H8 | 18.6562.74 | 0.0230.161 |
| H9 | 23.9863.11 | 0.0220.173 |
| H10 | 13.3252.32 | 0.0270.157 |
| H11 | 11.7262.17 | 0.0170.095 |
| H12 | 19.9882.84 | 0.0280.199 |
| H13 | 22.6533.02 | 0.0490.368 |
| H14 | 20.5212.87 | 0.0240.177 |
| H15 | 17.3232.64 | 0.0260.173 |
| H16 | 23.3203.06 | 0.0210.159 |
| H17 | 16.7902.60 | 0.0330.218 |
| H18 | 19.4552.80 | 0.0600.421 |
| H19 | 25.3193.19 | 0.0590.470 |
| H20 | 21.9872.98 | 0.00030.003 |
| H21 | 22.9203.04 | 0.049*0.372* |
| H22 | 23.7203.09 | 0.0260.205 |
| H23 | 34.6473.74 | 0.0280.264 |
| H24 | 45.3074.27 | 0.0460.490 |
| H25 | 27.9843.36 | 0.0310.259 |
| H26 | 35.9793.81 | 0.0300.292 |
| H27 | 21.0542.91 | 0.0340.248 |
| H28 | 17.9892.69 | 0.0200.137 |
| H29 | 12.7922.27 | 0.0130.075 |
| H30 | 47.9734.40 | 0.0710.779 |
| H31 | 18.3892.72 | 0.0350.239 |
| H32 | 31.3153.55 | 0.0270.239 |
| H33 | 22.1202.98 | 0.0350.261 |
| H34 | 28.6503.40 | 0.0550.465 |
| H35 | 53.3034.64 | 0.0240.277 |
| H36 | 25.9853.24 | 0.0280.225 |
| H37 | 23.4533.07 | 0.1000.762 |
| H38 | 17.5902.66 | 0.0430.285 |
| H39 | 27.7173.34 | 0.0620.514 |
| H40 | 19.7222.82 | 0.0200.142 |
| Max | 53.3034.64 | 0.7790.085 |
| Min | 10.6602.07 | 0.00030.003 |
| Average | 26.5373.21 | 0.2830.035 |

**Table 3.** Our results showing radon concentration compared to findings cited in literature.

| Country | Average of radon concentrations (Bq/m³) | Reference |
|---|---|---|
| Iraq(Bagdad) | 19.2 | [8] |
| Morocco | 10.2 | [17] |
| Iraq(Najaf) | 26.5 | This work |

# Conclusion

The forty herb samples collected from the local markets from various places in Iraq were evaluated for any potential radiation hazards by using SSNTDs (CR-39 detector). Our research indicates that the highest concentration of radon is found in roots and leaves, while the lowest radon concentration value is found in fruits. The radiological study shows that consumption of the studied medicinal plants would impose no health threat to the consumers.

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