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# STUDY OF THE RADON CONCENTRATIONS IN SOME MEDICINAL HERBS USING CR-39 DETECTOR

**Mohammed Abdul Kadhim Hadi Al – Sadi[1]* and Inaam H. Kadhim[2]***

[1]Environment Pollution Department, Collage of Environment, Al-Qasim Green University, Iraq.
[2]Physics Department, College of Education for Pure Sciences, University of Babylon, Iraq.

## Abstract

In this extensive work, properly investigated of radioactive content in some medicinal herbs typically consumed by local citizens and conduct the quantitative and qualitative estimate of some radionuclide and properly recognize the proper limits knowingly allowed by typically using CR-39 detector technology, the considerable number of selected species under extensive study reported 30 kind of Various medicinal plants, the radiation content will be accurately calculated in two possible ways, the first method included studied as a solid model adequately taking into account the different specific weight of each sample and the second method included studied as a water way often used by the consumer for the specific purpose of effective treatment, so the last number Both samples had reached 60 samples solid - liquid, after examination of the models examined in both cases are compared with indicators of radiation protection (IC RP), which was within the allowable limits of (200-800) $Bq/m^3$.

***Key words :*** Nuclear detector CR-39, radon gas, radioactive content, medicinal herbs, Background radiation.

## Introduction

The continuous process of properly utilizing the medicinal properties of some specific plants called herbal medicine, which naturally occupies a large place in agricultural and industrial production as a major source of botanical drugs and effective source that goes carefully into adequately preparing an exceptional medication, Especially after the World Health Organization unanimously confirmed the specific need to promptly return to effective treatment with medicinal herbs and typically reduce the practical use of modern medicines typically manufactured chemically negative impact where you develop properly modern medicines from medicinal herbs in multiple ways including squeeze or scarcely prepare a typical drink or adequately prepare their essential oils typically using organic or water extraction or prepared as precious ointment (Al-Masri and Amin, 2005). However, the widespread radioactive contamination in several various regions of the modern world especially in recent decades because of nuclear accidents or nuclear energy production and used in various agricultural and industrial lives, led to cordially invite intergovernmental organizations and extensive research to carefully study of the background radiation distribution of for all the environment system.

## Detector and Method

The CR-39 detector was used appropriately to carefully study the radioactive content of some medicinal herbs using cylindrical glass compartments with specific dimensions for study the radioactive content, The detector was irradiated during the 60 days and accurately calculated the diffusion constant K, which is equal $1.31\times10^{-3}$ $Bq.m^{-3}$, where these moral values naturally depend on the geometric dimensions of interaction room with the radius 1.05 cm. The background radiation was accurately measured within Laboratory with rate Nasha Rahim *et al.* (2008) $Tr.cm^{-2}$. Well, it was properly storing the selected samples to typically reach a radioactive equilibrium state. In the present study was carefully selected 30 different medical plant species and accurately calculate radioactive content in two possible ways, firstly, typically included studied as a sample with equal weights and different thicknesses typically depending on the

***Author for correspondence :** E-mail : moh_2005_ammed@yahoo.com[1], anaam_hani@@yahoo.com[2]

specific weight of each sample and secondly, included studied as a necessary Aqueous preparation which is used in most often by the local consumer for the practical purpose of effective treatment, properly fixed the considerable height at 3 Cm, as well as weight, considerable size for each sample a thoughtful, thus the final number of the samples equals 60 solid-liquid, the specific objective of this extensive study positively identify the radioactive content in both rare cases and direct comparison between them. Fig. 1: classroom interaction typically used to accurately calculate gas concentrations Radioactive radon. The selected samples were carefully washed with possible NaOH solution by water bath with normality (0.625 N), time 4 countless hours and the temperature ($70^0$C). Table 1: show the sample numbers,

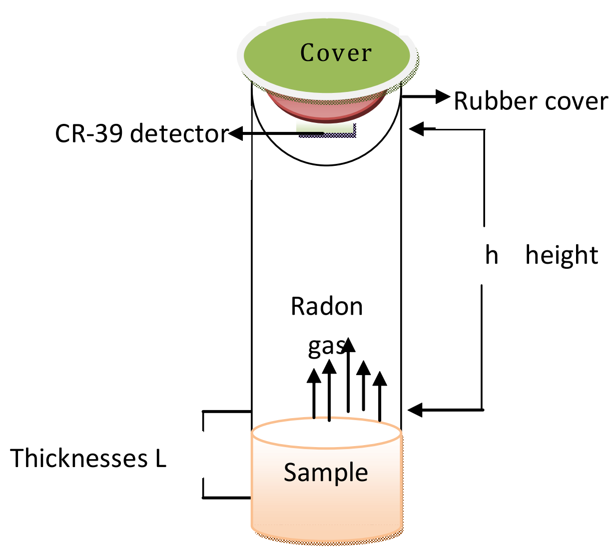


**Fig. 1:** Classroom interaction used to calculate gas concentrations Radioactive radon.

English and scientific names, part used of the plant, therapeutic medical uses.

**Mathematical Models**

The concentrations of the radon in the air include the seal cup from the equation (Al-Masri *et al.,* (2001).

$$Ca = C^0 t^0 p / tp^0 \quad ...(1)$$

($C^o$) is the concentration of radon, ($\rho^o$) is the track density per $mm^2$ on the calibrated dosimeter (*Ca*) is the concentration of radon in the air inside the seal cup. (ρ) is the track density per $mm^2$ for the detector with the samples (t) exposure time and (to) exposure time for calibration. Through the Radon concentration in air, we can calculate the radon concentration in each sample from the following equation (Nasha Rahim *et al.,* 2008). Through the Radon concentration in air we can calculated the radon concentration in each sample from the following equation (Nasha Rahim *et al.,* 2008).

$$C_W = Ca\lambda_{Rn} htL \quad ... (2)$$

where (*Ca*) is the concentration of radon in the air space given in $Bq.m^{-3}$, and (λRn) radon decay constant and equal to (0.1814 / Day), (h) distance from the sample surface inside the seal cup to the surface of the detector is equal to (8.8 cm), and (L) is the thickness of the sample. The activity of Radon in the samples (ARn) in (Bq) the unit could be determined through the relation (Nada Fadel *et al.,* 2009; Nidhala *et al.,* 2010).

$$A_{Rn} = CWV \quad ... (3)$$

Where V= Πr2h; (V) the volume of samples given in ($cm^3$) and the radius of the seal cup equal to (r = 3 cm). For uranium, concentration we can determined through the number of atoms of radon: (Ammar and Hana, 2010).

$$A_{Rn} = \lambda_{Rn} N \lambda_{Rn} \quad ... (4)$$

Using the equation of radioactive equilibrium for determining the number of atoms of uranium in the samples from the equation: (Abbas, 2013; Abdalsattar 2014).

$$N_U \lambda_U = N_{Rn} \lambda_{Rn} \quad ... (5)$$

Where $\lambda_U$ is decay constant of uranium ($3.4 \times 10^{-18}$ $sec^{-1}$), After calculating the amount of uranium, atoms in each sample we can calculated the mass of uranium (Wu) gm in each sample from the following equation: (Jabbar. 2014; Mahimid *et al.,* 1995)

$$W_U = N_U A_U N_{av} \quad ... (6)$$

Where AU: mass number of uranium $^{238}$U, $N_{av}$: Avogadro number ($6.02 \times 10^{34}$ $mol^{-1}$). Finally, we can calculate the mass of uranium in the unit (ppm) from the following equation:(Star, 1997; Munib and Firas, 1997)

$$C_U(ppm) = W_U W_S \quad ... (7)$$

Where ($W_S$) mass of the sample.

## Results and Discussion

**Quantitative and qualitative estimation of solid samples**

The trace's density rate for unstable Alpha particles was accurately calculated, elevated concentration for radon gas in the controlled airspace Ca, and inside samples Cs, respectively. As shown in table 2, the sensitive detector was set correctly at 5cm from the selected sample Which has in common mass equal to 10gm., it was carefully noted that the determined density of apparent trace for unstable Alpha particles recorded at the detector range Between (18-54) $Tr.cm^{-2}$ and the

**Table 1 :** Shows the sample numbers, English and scientific names, part used of the plant, therapeutic medical uses [2].

| SampleNo. | Part used | Scientific name | Plant name | Medical use |
|---|---|---|---|---|
| 1 | Leaves | Pimpinella anisum | Common thymus | Treatment of stomach, gas chased, removes puffiness |
| 2 | Stem | Curcuma | curcuma | Treat stomach disorders |
| 3 | Stem, leaves | Anethum graveolens | Dill Fruits | Maintain hormonal balance |
| 4 | Fruits | Aloe vera | Aloe | Digestion of fats, eliminating bad breath |
| 5 | Stem | Cinnamomum | cinnamon | Exothermic material gases, circulation |
| 6 | Leaves | Cassia | Senna | Cure chronic headaches and migraines |
| 7 | Peel the fruits of pomegranate | album | common mistletoe | Treatment of rheumatism |
| 8 | Flowering | Lavandula | true lavender | Relieves symptoms of shortness of breath |
| 9 | Stem | Rosmarinus | rosemary | Improves blood circulation and cure indigestion |
| 10 | The plant is full | Thymus vulgaris | Thymes | An anti-inflammatory and soothe chronic pain |
| 11 | Fruit | Zingiber officinale | common ginger | Expel intestinal gas, prevent abdominal cramps |
| 12 | Fruit | Crataegus | Hawthorn | Loosen the coronary arteries and and increases the speed of the heartbeat |
| 13 | Leaves | Glycyrrhiza glabra | Liquorice | For weight loss and prevention and cure the rash |
| 14 | Leaves | Green tea | Green tea | Helps prevent heart disease and stroke |
| 15 | Leaves, stem | Stachys | Basil | Pain reliever and sedative for the stomach and diuretic |
| 16 | Leaves | Origanum majorana | Marjoram | Treating poor digestion and an antioxidant |
| 17 | Flowering | Matricaria recutita | German chamomile | Treating anxiety and depression and helps you sleep |
| 18 | Flowering | Borago officinalis | Borago officinalis | Treating skin infections such as prevention |
| 19 | Leaves, stem | Salvia officinalis | Common sage | Curing gums and teeth |
| 20 | Seeds | Prunus mahaleb | Prunus mahaleb | Strengthens looking, hearing, reduces the heartbeat |
| 21 | Seeds | Petroselinum | Parsley root | Cure bleeding gums and weak teeth |
| 22 | Seeds | Glycine max | Soy | Prevent osteoporosis and helps to get rid of obesity |
| 23 | Seeds | Cuminum | Cumin | Treatment of skin disorders |
| 24 | Seeds | Lepidium sativum | Darden cress | expectorant, absorbs odors |

***Table 1 contd....***

***Table 1 contd....***

| | | | | |
|---|---|---|---|---|
| 25 | Seeds | Foeniculum vulgare | Fennel | Newborn women benefit and increases their milk |
| 26 | Seeds | Linum usitatissimum | Linum | Support the immune system, treat coughs, acne treatment |
| 27 | Leaves, stem | Melissa officinalis | Lemon balm | Skin care and treat headaches |
| 28 | Leaves, stem | Mentha | Mint | Fragrant scent and improves appetite |
| 29 | Flowering | Lavandula | Lavender | Considered a sedative, anti-bacteria and fungi and depression |
| 30 | Seeds | Trigonella foenum-graecum | Common juniper | Powerful Wizard of chest pain, cough and asthma |

**Table 2 :** The traces density rate for unstable Alpha particles was accurately calculated, elevated concentration for radon gas in the controlled airspace Ca, and inside samples Cs, respectively.

| Sample No. | $D_{(Rn)}\times10^{-2}$ Tr.Cm$^{-2}$/T | $\rho_{(Rn)}$ Tr.Cm$^{-2}$ | Thicknesses L(cm) | Cs (Bq/m$^3$) | Ca (Bq/m$^3$) |
|---|---|---|---|---|---|
| 1 | 1.53 | 22 | 3.1 | 302.223 | 11.662 |
| 2 | 3.06 | 44 | 3.1 | 634.669 | 23.325 |
| 3 | 1.46 | 21 | 3.4 | 288.486 | 11.132 |
| 4 | 1.25 | 18 | 2.8 | 259.637 | 9.5420 |
| 5 | 2.22 | 32 | 3.4 | 461.578 | 16.964 |
| 6 | 1.60 | 23 | 3.1 | 276.466 | 12.193 |
| 7 | 1.39 | 20 | 2.8 | 274.749 | 10.602 |
| 8 | 2.43 | 35 | 3.4 | 439.000 | 18.554 |
| 9 | 3.61 | 52 | 3.6 | 681.876 | 27.566 |
| 10 | 2.22 | 32 | 3.5 | 401.372 | 16.964 |
| 11 | 1.25 | 18 | 2.6 | 236.034 | 9.5420 |
| 12 | 2.15 | 31 | 2.9 | 388.829 | 16.433 |
| 13 | 2.57 | 37 | 2.9 | 444.749 | 19.614 |
| 14 | 2.71 | 39 | 3.1 | 450.038 | 20.674 |
| 15 | 2.85 | 41 | 3.5 | 514.258 | 21.735 |
| 16 | 1.74 | 25 | 3.3 | 360.608 | 13.253 |
| 17 | 2.92 | 42 | 3.2 | 526.801 | 22.265 |
| 18 | 2.99 | 43 | 3.8 | 620.245 | 22.795 |
| 19 | 2.50 | 36 | 3.8 | 494.547 | 19.084 |
| 20 | 1.67 | 24 | 3.8 | 276.947 | 12.723 |
| 21 | 3.75 | 54 | 3.1 | 778.912 | 28.626 |
| 22 | 1.53 | 22 | 3.1 | 275.943 | 11.662 |
| 23 | 1.94 | 28 | 3.2 | 336.567 | 14.843 |
| 24 | 2.71 | 39 | 2.8 | 489.172 | 20.674 |
| 25 | 2.50 | 36 | 3.1 | 432.729 | 19.084 |
| 26 | 3.82 | 55 | 3.2 | 661.114 | 29.156 |
| 27 | 1.74 | 25 | 3.1 | 313.572 | 13.253 |
| 28 | 1.94 | 28 | 3.1 | 351.200 | 14.843 |
| 29 | 1.67 | 24 | 3.1 | 301.029 | 12.723 |
| 30 | 2.29 | 33 | 3.1 | 413.915 | 17.494 |

**Table 3 :** Activity of radon gas, radium content effectively, the number of atoms of radon and uranium, the concentration of samples in ppm units, activity of polonium D * $^{218}$Po, D$^{218}$Po.

| Sample No. | A(Ra) Bq $\times10^{+2}$ | A(Rn) Bq $\times10^{-3}$ | Cu (ppm) $\times10^{-2}$ | N(u) $\times10^{+14}$ | N(Rn) $\times10^{+3}$ | D* ($^{218}$Po) Bq/m$^2$ | D ($^{218}$Po) Bq/m$^2$ |
|---|---|---|---|---|---|---|---|
| 1 | 4.551 | 2.197 | 1.772 | 4.484 | 1.046 | 2.025 | 0.498 |
| 2 | 2.276 | 4.394 | 3.544 | 8.968 | 2.093 | 4.051 | 0.996 |
| 3 | 4.768 | 2.097 | 1.691 | 4.280 | 0.998 | 1.933 | 0.475 |
| 4 | 5.563 | 1.798 | 1.450 | 3.669 | 0.856 | 1.657 | 0.407 |
| 5 | 3.129 | 3.196 | 2.577 | 6.522 | 1.522 | 2.946 | 0.724 |
| 6 | 4.353 | 2.297 | 1.852 | 4.688 | 1.094 | 2.117 | 0.520 |
| 7 | 5.006 | 1.997 | 1.611 | 4.076 | 0.951 | 1.841 | 0.453 |
| 8 | 2.861 | 3.495 | 2.819 | 7.134 | 1.664 | 3.222 | 0.792 |
| 9 | 1.926 | 5.193 | 4.188 | 1.060 | 2.473 | 4.787 | 1.177 |
| 10 | 3.129 | 3.196 | 2.577 | 6.522 | 1.522 | 2.946 | 0.724 |
| 11 | 5.563 | 1.798 | 1.450 | 3.669 | 0.856 | 1.657 | 0.407 |
| 12 | 3.230 | 3.096 | 2.497 | 6.318 | 1.474 | 2.854 | 0.701 |
| 13 | 2.706 | 3.695 | 2.980 | 7.541 | 1.760 | 3.406 | 0.837 |
| 14 | 2.567 | 3.895 | 3.141 | 7.949 | 1.855 | 3.591 | 0.882 |
| 15 | 2.442 | 4.095 | 3.302 | 8.356 | 1.950 | 3.775 | 0.928 |
| 16 | 4.005 | 2.497 | 2.013 | 5.095 | 1.189 | 2.302 | 0.566 |
| 17 | 2.384 | 4.195 | 3.383 | 8.560 | 1.997 | 3.867 | 0.950 |
| 18 | 2.329 | 4.294 | 3.463 | 8.764 | 2.045 | 3.959 | 0.973 |
| 19 | 2.781 | 3.595 | 2.899 | 7.337 | 1.712 | 3.314 | 0.815 |
| 20 | 4.172 | 2.397 | 1.933 | 4.892 | 1.141 | 2.210 | 0.543 |
| 21 | 1.854 | 5.393 | 4.349 | 11.01 | 2.568 | 4.972 | 1.222 |
| 22 | 4.551 | 2.197 | 1.772 | 4.484 | 1.046 | 2.025 | 0.498 |
| 23 | 3.576 | 2.796 | 2.255 | 5.707 | 1.332 | 2.578 | 0.634 |
| 24 | 2.567 | 3.895 | 3.141 | 7.949 | 1.855 | 3.591 | 0.882 |
| 25 | 2.781 | 3.595 | 2.899 | 7.337 | 1.712 | 3.314 | 0.815 |
| 26 | 1.821 | 5.493 | 4.430 | 11.21 | 2.616 | 5.064 | 1.245 |
| 27 | 4.005 | 2.497 | 2.013 | 5.095 | 1.189 | 2.302 | 0.566 |
| 28 | 3.576 | 2.796 | 2.255 | 5.707 | 1.332 | 2.578 | 0.634 |
| 29 | 4.172 | 2.397 | 1.933 | 4.892 | 1.141 | 2.210 | 0.543 |
| 30 | 3.034 | 3.296 | 2.658 | 6.726 | 1.569 | 3.038 | 0.747 |

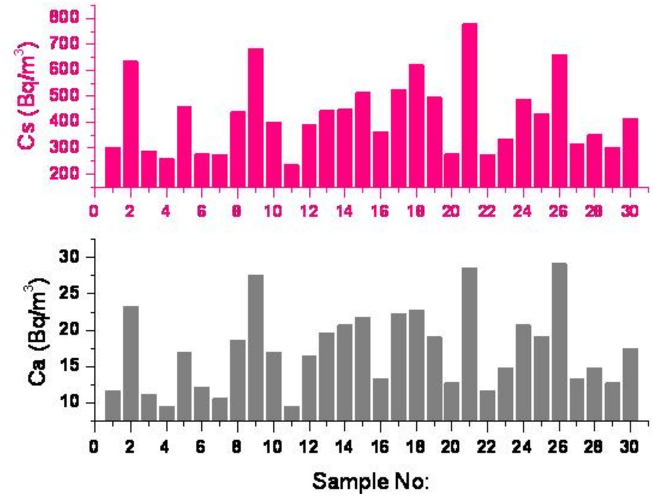


**Fig. 2 :** Radon concentration airspaces Ca, and inside samples Cs as function of the number of samples.

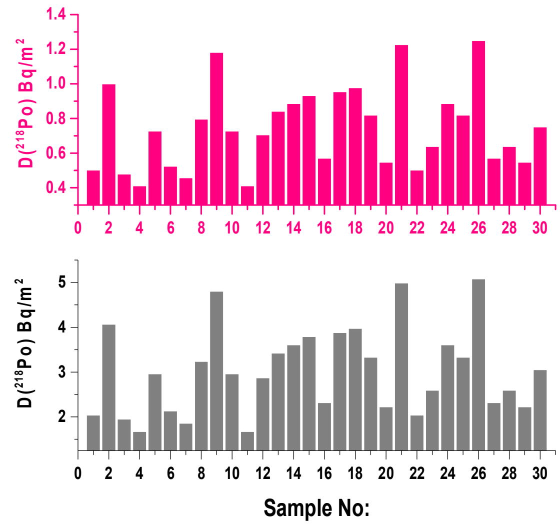


**Fig. 5 :** Activity of the polonium on detector face, wall of chamber as a function of the number of samples.

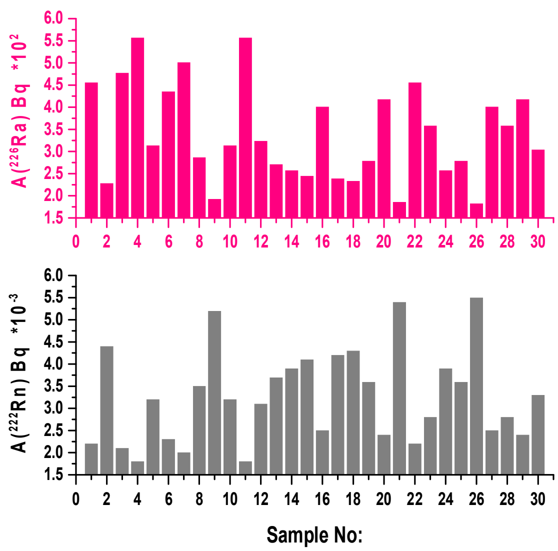


**Fig. 3 :** Shows the activity for radium and radon as a function of sample numbers.

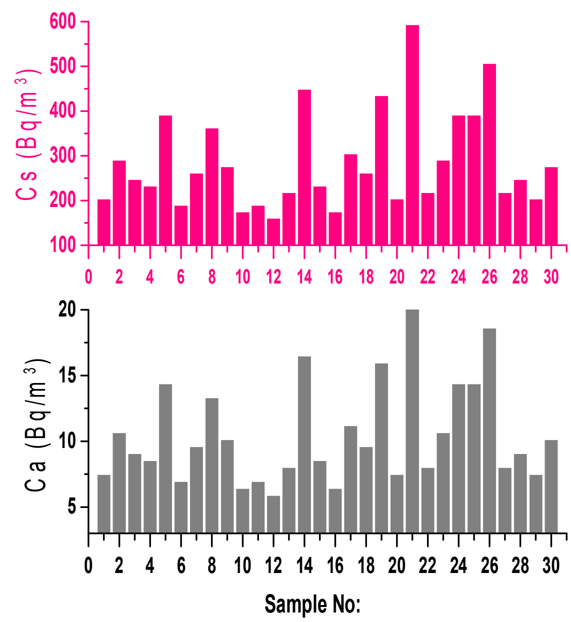


**Fig. 6 :** Radon concentration airspace Ca, and inside samples Cs as function of the number of samples.

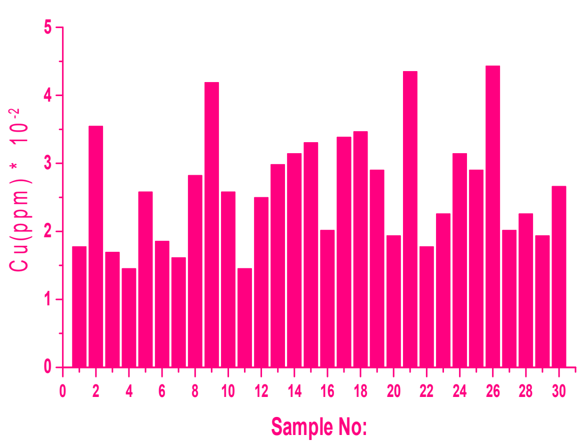


**Fig. 4 :** Shows the uranium-equivalent concentrations in pm units of the samples.

elevated concentration of radon in controlled airspace ranged between less valuable Bq/m3 (9.5420) and the highest value of (28.626) Bq/$m^3$, for samples 21, 4 respectively, either radon concentration within the selected sample ranged between less valuable Bq/$m^3$ (259.637) and the highest value of (778.912) Bq/$m^3$ for the same samples.

To accurately identify the observed variation in elevated concentration for each sample, were calculated Ca, Cs concentrations as a function of the considerable number of selected samples, as in fig. 2. It were carefully observed that the Cs, Ca concentrations harmony with each other at to rising and fall in the possible value of

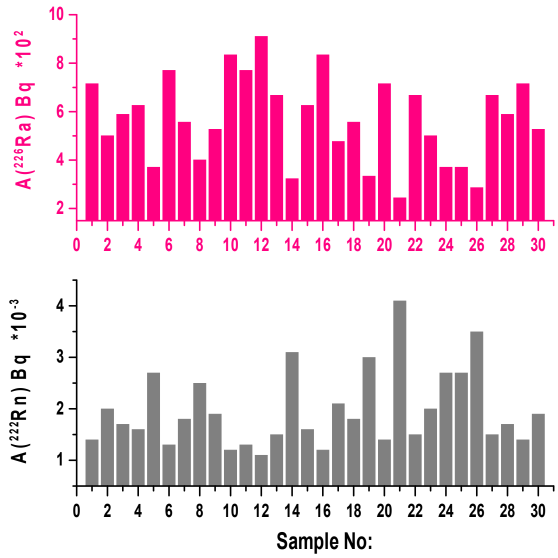


**Fig. 7 :** Shows the activity for radium and radon as a function of sample numbers.

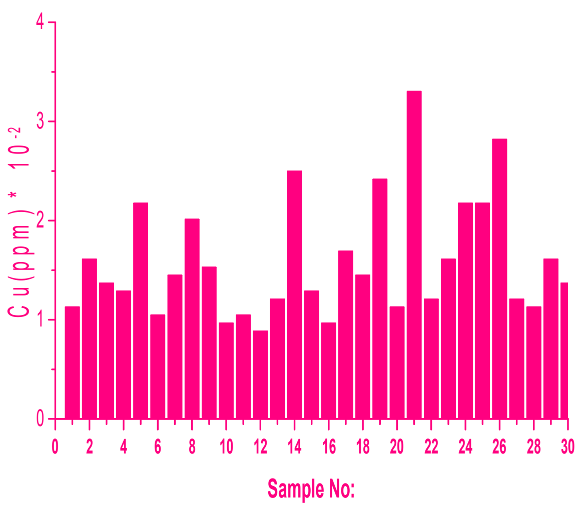


**Fig. 8 :** Shows the uranium equivalent concentrations in ppm units.

elevated concentration for each sample, and that goes carefully for all the selected samples under extensive study, due to its functional dependence of radon concentration within the selected sample on radon concentration in the controlled airspace, mass. It was also noted that radon concentration within each sample has doubled to 27 appropriate times compared with controlled airspace, so, the average size of the selected samples carefully studied equals 7.743 $\times 10^{-6}$ $m^3$, the table 3 shows the activity of radon, Radium content is effective, the considerable number of atoms of radon and uranium atoms, the elevated concentration of selected samples in ppm units, activity of polonium $^{218}$Po in detector face, on

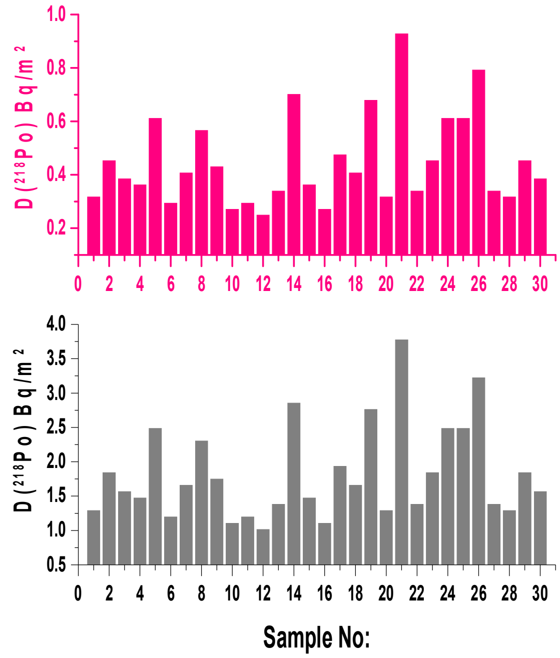


**Fig. 9:** Activity $^{218}$Po in detector face, on the walls of the classroom in Bq.$m^{-2}$ units.

the walls of the classroom (interaction chamber) in Bq.$m^{-2}$ standard units.

From the table 3, It has been observed the activity values for radon gas within the selected samples ranged from (1798-5.393)$\times 10^{-3}$Bq for selected samples (Nasha Rahim *et al.,* 2008; Mahimid *et al.,* 1995), this values moreover contain the highest concentration due to Interconnection between the activity and determined concentration of the isotope for each sample Show the activity for radium and radon as a function of sample numbers. (Parent nucleus) show the activity for radium and radon as a function of sample numbers Fig.

The determined concentration of uranium in ppm units naturally depends on the observed ratio between the considerable weight of uranium-235 and the considerable weight of the studied sample, which naturally depends in turn on the amount of uranium atoms-238 and the mass of the selected sample, it's worth accurately noting that uranium concentrations have increased particularly in samples 26, 21, 9, 2, The values accurately calculated in all selected samples typically ranged between ppm (1.450-4.430) as values confined to samples 26 and 4, respectively, fig. 4 shows the uranium-equivalent concentrations in ppm units of the selected samples under extensive study.

The activity of the radioactive polonium D$\times^{218}$Po on the detector face and D$^{218}$Po and the walls of a cylinder is based on the considerable dimensions of the reaction chamber, which are accurately represented by the

**Table 4:** The traces density rate for Alpha particles, concentration for radon gas in the airspace Ca, and inside samples Cs, respectively.

| Sample No. | D(Rn)×$10^{-2}$ Tr.$Cm^{-2}$/T | ρ(Rn) Tr.$Cm^{-2}$ | Cs (Bq/m3) | Ca (Bq/m3) |
|---|---|---|---|---|
| 1 | 0.97 | 14 | 201.940 | 7.4215 |
| 2 | 1.39 | 20 | 288.486 | 10.602 |
| 3 | 1.18 | 17 | 245.213 | 9.0119 |
| 4 | 1.11 | 16 | 230.789 | 8.4818 |
| 5 | 1.88 | 27 | 389.456 | 14.313 |
| 6 | 0.90 | 13 | 187.516 | 6.8914 |
| 7 | 1.25 | 18 | 259.637 | 9.5420 |
| 8 | 1.74 | 25 | 360.608 | 13.253 |
| 9 | 1.32 | 19 | 274.062 | 10.072 |
| 10 | 0.83 | 12 | 173.092 | 6.3613 |
| 11 | 0.90 | 13 | 187.516 | 6.8914 |
| 12 | 0.76 | 11 | 158.667 | 5.8312 |
| 13 | 1.04 | 15 | 216.365 | 7.9517 |
| 14 | 2.15 | 31 | 447.153 | 16.433 |
| 15 | 1.11 | 16 | 230.789 | 8.4818 |
| 16 | 0.83 | 12 | 173.092 | 6.3613 |
| 17 | 1.46 | 21 | 302.910 | 11.132 |
| 18 | 1.25 | 18 | 259.637 | 9.5420 |
| 19 | 2.08 | 30 | 432.729 | 15.903 |
| 20 | 0.97 | 14 | 201.940 | 7.4215 |
| 21 | 2.85 | 41 | 591.396 | 21.735 |
| 22 | 1.04 | 15 | 216.365 | 7.9517 |
| 23 | 1.39 | 20 | 288.486 | 10.602 |
| 24 | 1.88 | 27 | 389.456 | 14.313 |
| 25 | 1.88 | 27 | 389.456 | 14.313 |
| 26 | 2.43 | 35 | 504.851 | 18.554 |
| 27 | 1.04 | 15 | 216.365 | 7.9517 |
| 28 | 1.18 | 17 | 245.213 | 9.0119 |
| 29 | 0.97 | 14 | 201.940 | 7.4215 |
| 30 | 1.32 | 19 | 274.062 | 10.072 |

proportional radius of the cylinder r and the height of the reaction chamber h. Note that another factor added in calculate of the activity of the area unit on the face of the detector is the range of alpha particles emits form sample The results showed in fig. 5. The flexible coupling of the values scarcely calculated in the height and the decrease together with the observation that the activity of the area unit at the detector face has lower values than in the walls of the reaction chamber due to the range of alpha particles emitted from the selected sample.

**Quantitative and qualitative estimation of samples in the water content**

The traces density rate for unstable Alpha particles was accurately calculated, determined concentration for radon gas in the controlled airspace Ca, and inside samples Cs, respectively. As shown in the table 4, that the thickness of the selected sample fixed at 3cm, the class size of the selected sample was properly a fixed value equals to 36.924×10-6 m airspace of the cylindrical chambers was also fixed in the same way as in the solid samples. Carefully noted that the trace density for unstable Alpha particles recorded at the detector range Between (41-11) for samples 12, 21 respectively, the radon concentrations between the highest and lowest values in controlled airspace were (21.735), (5.8312) Bq/m3. Respectively, While the radon concentrations between the highest and lowest values within samples were (591.396) (158.667) Bq/m3, respectively for the same samples.

The determined concentration of Ca, Cs in the water content was drawn as a function of the samples number as in fig. 6. It was carefully observed that the Cs, Ca concentrations harmony with each other at to rising and fall in the value of determined concentration for each sample, This properly applies to all the selected samples under study and for the similar reason in solid samples.

Also in water content, was properly calculated radon activity, effective Radium content, the number of atoms of radon and uranium atoms, the samples concentration in ppm units, activity of polonium $^{218}$Po in detector face, on the walls of the classroom (interaction chamber) in Bq.$m^{-2}$ units, as shown that fig. 5.

It was carefully observed in Table 5, that the activity values in the water content was ranged between (1.099-4.095)× $10^{-3}$ Bq for the same samples 21, 12 which include a high concentration. That the Activity of the radium isotope increased compared with the activity of the daughter nucleus (radon) in general and all the samples, fig. 7 shows the activity of radon and radium in their water content. Also in water content, was properly calculated radon activity, effective Radium content, the considerable number of atoms of radon and uranium atoms, the samples concentration in ppm units, activity of polonium $^{218}$Po in detector face, on the walls of the classroom (interaction chamber) in Bq.$m^{-2}$ units as shown that in fig. 7.

The concentrations of uranium in ppm unit in the water content have increased in particular in the samples 5, 8, 14, 19, 21, 26, because of its low water solubility, the values calculated in all samples ranged from (0.886-2.819) ppm for the samples 26 and 12, respectively. Fig. 8 correctly shows the uranium equivalent concentrations in ppm units.

While fig. 9 shows polonium activity $^{218}$Po in detector face, on the walls of the classroom (interaction chamber) in Bq.$m^{-2}$ units.

**Percentage of the radon transform into the aquatic preparations**

For the purpose of recognizing the quantitative

**Table 5 :** Activity of radon gas, radium content effectively, the number of atoms of radon and uranium, the concentration of samples in ppm units, activity of polonium D * $^{218}$Po, D$^{218}$Po.

| Sample No. | A(Ra) Bq×$10^{+2}$ | A(Rn) Bq×$10^{-3}$ | Cu (ppm) ×$10^{-2}$ | N(u) ×$10^{+14}$ | N(Rn) ×$10^{+3}$ | D*($^{218}$Po) Bq/m$^2$ | D($^{218}$Po) Bq/m$^2$ |
|---|---|---|---|---|---|---|---|
| 1 | 7.152 | 1.398 | 1.128 | 2.853 | 0.666 | 1.289 | 0.317 |
| 2 | 5.006 | 1.997 | 1.611 | 4.076 | 0.951 | 1.841 | 0.453 |
| 3 | 5.890 | 1.698 | 1.369 | 3.465 | 0.809 | 1.565 | 0.385 |
| 4 | 6.258 | 1.598 | 1.289 | 3.261 | 0.761 | 1.473 | 0.362 |
| 5 | 3.708 | 2.696 | 2.175 | 5.503 | 1.284 | 2.486 | 0.611 |
| 6 | 7.702 | 1.298 | 1.047 | 2.650 | 0.618 | 1.197 | 0.294 |
| 7 | 5.563 | 1.798 | 1.450 | 3.669 | 0.856 | 1.657 | 0.407 |
| 8 | 4.005 | 2.497 | 2.013 | 5.095 | 1.189 | 2.302 | 0.566 |
| 9 | 5.270 | 1.898 | 1.530 | 3.872 | 0.904 | 1.749 | 0.430 |
| 10 | 8.344 | 1.198 | 0.966 | 2.446 | 0.571 | 1.105 | 0.272 |
| 11 | 7.702 | 1.298 | 1.047 | 2.650 | 0.618 | 1.197 | 0.294 |
| 12 | 9.103 | 1.099 | 0.886 | 2.242 | 0.523 | 1.013 | 0.249 |
| 13 | 6.675 | 1.498 | 1.208 | 3.057 | 0.713 | 1.381 | 0.339 |
| 14 | 3.230 | 3.096 | 2.497 | 6.318 | 1.474 | 2.854 | 0.701 |
| 15 | 6.258 | 1.598 | 1.289 | 3.261 | 0.761 | 1.473 | 0.362 |
| 16 | 8.344 | 1.198 | 0.966 | 2.446 | 0.571 | 1.105 | 0.272 |
| 17 | 4.768 | 2.097 | 1.691 | 4.280 | 0.998 | 1.933 | 0.475 |
| 18 | 5.563 | 1.798 | 1.450 | 3.669 | 0.856 | 1.657 | 0.407 |
| 19 | 3.338 | 2.996 | 2.416 | 6.114 | 1.427 | 2.762 | 0.679 |
| 20 | 7.152 | 1.398 | 1.128 | 2.853 | 0.666 | 1.289 | 0.317 |
| 21 | 2.442 | 4.095 | 3.302 | 8.356 | 1.950 | 3.775 | 0.928 |
| 22 | 6.675 | 1.498 | 1.208 | 3.057 | 0.713 | 1.381 | 0.339 |
| 23 | 5.006 | 1.997 | 1.611 | 4.076 | 0.951 | 1.841 | 0.453 |
| 24 | 3.708 | 2.696 | 2.175 | 5.503 | 1.284 | 2.486 | 0.611 |
| 25 | 3.708 | 2.696 | 2.175 | 5.503 | 1.284 | 2.486 | 0.611 |
| 26 | 2.861 | 3.495 | 2.819 | 7.134 | 1.664 | 3.222 | 0.792 |
| 27 | 6.675 | 1.498 | 1.208 | 3.057 | 0.713 | 1.381 | 0.339 |
| 28 | 5.890 | 1.698 | 1.128 | 3.465 | 0.809 | 1.289 | 0.317 |
| 29 | 7.152 | 1.398 | 1.611 | 2.853 | 6.658 | 1.841 | 0.453 |
| 30 | 5.270 | 1.898 | 1.369 | 3.872 | 9.036 | 1.565 | 0.385 |

estimate of radon transferred from solid samples to their aquatic formulations within the sample Cs, the ratio between the concentrations of this isotope was taken in aquatic preparations and solid state as indicated in the table 6.

It was noted that the transition rates vary depending on the method of preparation aquatic preparations of each sample, the concentration of radon gas in which the values vary according to the time and temperature of the preparation, which is caused by increasing the evaporation of part of the radon and thus reducing the concentration within the water content, The International Radiation Protection Organization (ICRP) issued warnings on the limits of exposure to radon through the permissible limits of (200-800) Bq/m$^3$, which was confirmed by the International Atomic Energy Agency (IAEA).[14]. Thus The concentration of radon produced from all solid-liquid samples is within the permissible limits. So the highest concentration in samples was (778.912) Bq/m$^3$ and (591.396) Bq/m$^3$ in the sample number 21 in solid and water content, respectively.

## Conclusion

1. Concentrations of radon gas calculated in the solid samples have a high values for all samples under study compared to their concentrations in their water content.
2. Radon concentrations calculated within the sample are higher than the values calculated within the aerospace space,

**Table 6 :** Percentage of the radon transform into the aquatic preparations with in sample.

| Sample No. | Percentage ratio(%) of the radon transform into the aquatic preparations | Sample No. | Percentage ratio(%) of the radon transform into the aquatic preparations | Sample No. | Percentage ratio(%) of the radon transform into the aquatic preparations |
|---|---|---|---|---|---|
| 21 | 78.4 | 11 | 40.8 | 1 | 45.4 |
| 22 | 85.7 | 12 | 48.6 | 2 | 85.0 |
| 23 | 79.6 | 13 | 99.3 | 3 | 88.9 |
| 24 | 90.0 | 14 | 44.9 | 4 | 84.4 |
| 25 | 76.4 | 15 | 48.0 | 5 | 67.8 |
| 26 | 69.0 | 16 | 57.5 | 6 | 94.5 |
| 27 | 69.8 | 17 | 41.8 | 7 | 82.1 |
| 28 | 67.1 | 18 | 87.5 | 8 | 40.2 |
| 29 | 66.2 | 19 | 72.9 | 9 | 43.1 |
| 30 | 66.2 | 20 | 75.9 | 10 | 79.4 |

due to high activity that are within the sample.

3. The values reduction of the radon concentration generally in the water content, due to the water preparation of the samples at different temperatures and evaporation of part of it.
4. All concentration values for radon gas calculated in their solid state and in their water content are within the permissible limits, according to IAEA publications between Bq / m3 (200-800).

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