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Effective radium activity, radon exhalation rate and uranium concentrations in medicinal plants

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Abstract. In the present work, effective radium activity, radon exhalation rates and uranium in medicinal plants have been measured,samples collected from Iraqi markets. Sealed cup technique containing CR-39 solid state nuclear detector was used. Radium concentration varies from (0.0297±0.004) Bq/kg to (0.327±0.126) Bq/kg with an average of (0.142±0.025) Bq/kg. The radon exhalation rate in terms of area varies from (2.287±0.384) µBq/m2.d to (25.193±9.729) µBq/m2.d with an average of (10.986±1.989) µBq/m2.d, while uranium concentrations were ranged from (0.018±0.002) ppm to (0.202±0.057) ppm with an average (0.087±0.002) ppm. The values of radium concentration ,exhalation rates and uranium in all the medicinal plants samples were less than the recommended by the Organization of Economic Cooperation and Development (OECD) , United Nations and Scientific Committee On The Effects Of Atomic Radiation (UNSCEAR) respectively. The results have revealed that the radium and uranium concentration as well as exhalation rates in studied medicinal plants and the associated exhalation radon does not pose risk to human health.

1. Introduction

The fundamental component of our life bolster system is considered to be within the soil, water, air and vegetation, from which it is breathed in and ingested into the body. These natural components contain quantifiable sum of radioactivity. The particular metabolic character of the plant species may lead to aggregation of radio-nuclides in their organs, which may assist depend upon the physic-chemical characteristics of the soil . In this manner, there may be expanded hazard to human populace through nourishment chain. The essential sources of components from the environment to plants are: air, water and the soil [1]. The radionuclides show within the environment are exchanged to plants by two ways to begin with backhanded strategy take-up from soil through roots. When food crops are developed within the sullied soil, the action is shifted from the soil to the roots and after that in shoots. At the conclusion, action is exchanged to the human count calories [2]. These radionuclides can get exchanged into plants at the side the supplements amid mineral take-up and gather in different parts and indeed reach consumable parcels [3]. Second, it is coordinate strategy assimilation through airborne parts of the plants. Nearness of radioactivity in plant organs has been surveyed by different laborers [1]. The plants roots are normally related to microorganisms, and these affiliations can have coordinate or circuitous impacts on the versatility, accessibility and securing of components by plants [4]. Generally radionuclides are the source of the three sorts of the radiation are alpha particles, beta particles and gamma beams [5].The essential sources of components from the environment to plants are: air, water and the soil [1]. The radiological impact of the employments of fertilizers in soil is due to the internal irradiation of the respiratory organ by the alpha particles, brief lived radon - thoron offspring and the external irradiation of the body by gamma beams radiated from the radionuclides. Radon is carcinogenic to people and capable for primary common radiation presentation to human being [6,7]. There are many studies concern about study the concentration of radioactivity in medicinal plants [8-11].

The aim of this work is to measure effective radium activity, radon exhalation rate and uranium concentrations in some samples of medicinal plants that collected from Iraqi markets using SSNTD (CR-39).

2. Materials and methods

2.1. Collection samples

Forty samples of medicinal plants were collected from the local markets at various places in Najaf city, Iraq. Samples were classified into groups as shown in Table 1 and Figure 1 according to the medicinal plants part that used in treatment.

Table 1. List of medicinal plants used in the study

No.	Sample Type	Sample Code	Sample Name		Origin
			Trade name	Scientific name	
1	Leaves	M1	Senna	*CassaisennaL.*	Saudi Arabia
2		M3	Ziziphus	*Ziziphusspina-Christi L.*	Iraq
3		M5	Peppermint	*MenthapiperitaL.*	Iraq
4		M7	Aelchenan	*Anabasis spp.*	Iraq
5		M8	Green tea	*Camellia sinensis*	China
6		M13	Hawthorn	*Crataegus spp.*	USA
7		M15	Myrtle	*MyrtuscommunisL.*	Iraq
8		M20	Sage	*Salvia officinalis*	India
9		M21	Maidenhair fern	*Adiantumcapillus –venerisL.*	USA
10		M26	Bay leaves	*Laurusnobilis*	Syria
11	Flowers and Fruits	M2	Safflower	*Carthamustinctorius*	Iran
12		M6	Balanite	*Balanitesaegyptica(L.) Del.*	Egypt
13		M12	Greater plantain	*Plantago major L.*	India
14		M16	White cedar	*Thujaoccidentalis*	Syria
15		M19	Chamomile	*Matricariachamomilla L.*	Syria
16		M24	Hollyhock	*Alcearosea L.*	India
17		M29	Roselle	*Hibiscus sabdariffaL.*	Iraq
18		M36	Colocynth	*Citrulluscolocynthis (L.) Shradc*	Iraq
19		M37	Primrose	*Primula vulgaris L.*	west Asia
20		M38	Borage	*Boragoofficinales*	Iran
21	other	M4	Hops	*HumuluslupulusL.*	Iran
22		M9	Fenugreek	*TrigonellafoenumgraecumL.*	India
23		M10	Sweet marjoram	*Origanummajorana*	Middle east
24		M11	Ginger	*Zingiberofficinale*	India
25		M14	Chokecherry	*PrunusvirginianaL*	Azerbaijan
26		M17	Rosemary	*RosmarinusofficinalisL.*	Mediterranean sea
27		M18	Chicory	*CichoriumintybusL.*	Iraq
28		M39	Coltsfoot	*Tassilagofarfara*	North Asia
29		M22	Black mustard	*Brassica nigra(L.) W.D.J. Koch*	China
30		M23	Cyperus	*Cyperusesculentus*	Egypt
31		M25	Ginkgo	*Ginkgo biloba.*	Iran
32		M27	Corn Mint or Bo He	*Menthahalpocalyx*	India
33		M28	Black cumin	*Nigella sativa L.*	India
34		M30	Horse tail	*EquisetiumarvenseL.*	Egypt

35		M31	African Rue	*RutachalepensisL.*	Saudi Arabia
36		M32	Flax	*Linumusitatissimum L.*	Iran
37		M33	Stout bien	*Angelica archangelicaL.*	China
38		M34	Yarrow	*Achilleamillefolium*	Iran
39		M35	Nutgrass	*CyperusrotundusL.*	Saudi Arabia
40		M40	Rose of Jericho	*AnastaticahierochunticaL.*	Palestine

Figure 1. Pictures of medicinal plants studied

2.2. *preparation samples*

These samples were crushed to fine powder by using electrical mill, where we measured by using a highly sensitive scale with a tolerance ±0.01%, from five to twenty grams of each individual sample for further analysis. Before use, containers were washed with dilute hydrochloric acid and rinsed with distilled. Then put the samples in plastic containers and assigned a code specific to each individual sample .Measurements were carried out upon 30 days after reaching the radiation equilibrium [12]. 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 (1×1) cm2 and 1mm thick was placed at the middle of the underside of the cover and affixed with an adhesive tape.

The distance between the surfaces of the sample and reagent was 5cm and the sample height was 2cm. The container was then sealed for three months; during that time, alpha particles emitted by radon and their daughters as show a diffusion chamber Figure 2.

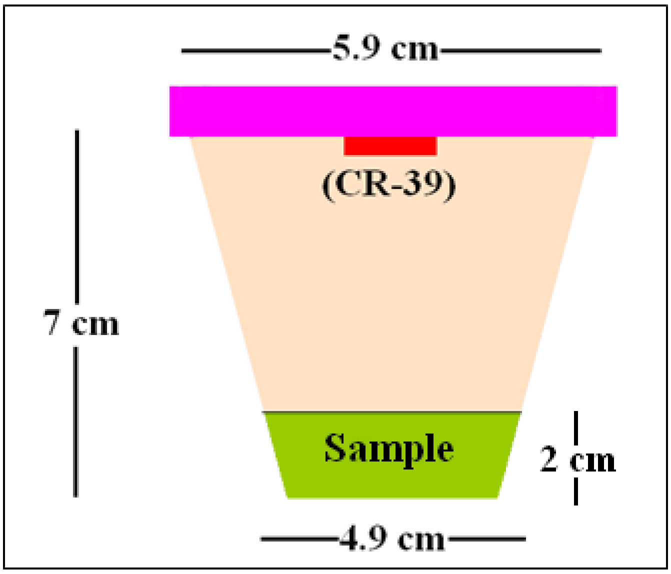

Figure 2. The plastic container used to study alpha particles of medicinal plant samples

The detectors were developed in NaOH solution 6.25 N at 70˚C for 7 hours; after chemical etching, α particle track densities were determined by an optical microscope (HDCE-50B digital camerasystem microscope N-120A) of 400X Magnification power.

2.3. *Calculation of radium, radon exhalation rate and uranium*

The Radon centration C_{Rn} in (Bq/m^3) was determined by the following equation[13,14]:

$$C_{Rn} = \frac{\rho}{KT} \qquad (1)$$

Where, K : is the calibration factor in terms of (track.cm^{-2}/Bq.d.m^{-3}), T was the total exposure time (90 day), ρ (Track /cm^2) was the density of the tracks in the detectors was calculated according to the following equation [15].

$$\rho = \frac{N_{ave.}}{A} \qquad (2)$$

Where, N_{ave} was an average of total tracks (Track) and A is an area of a view field (cm^2).

The radium concentration C_{Ra}(Bq/kg) in sample has been calculated according to the following relation [13]:

$$C_{Ra} = \frac{\rho h A}{KT_{eff} m} \qquad (3)$$

Where h was the distance between the samples surface and detectors, A (m^2) is the cross section area of the test tube, m is the mass of sample and T_{eff} (day) is the effective exposure time can calculated from [16]:

$$T_{eff} = T - \frac{1}{\lambda_{Rn}}\left(1 - e^{-\lambda_{Rn}T}\right) \tag{4}$$

Where $\lambda_{Rn}$was the decay constant of radon which equal to ($0.1814d^{-1}$)

The radon exhalation rate in terms of area *Exim* ($Bq/m^2.d$) was calculated as follows [17]:

$$Ex = CRa\left(\frac{\lambda_{Ra}}{\lambda_{Rn}}\right)\frac{1}{T_{eff}} \tag{5}$$

Where λ_{Ra} was the decay constant of radium ($1.1814\times10^{-6}d^{-1}$).
can be calculated radon concentration within the sample C_{Rn} , the following relation was used [18]:

$$C_{Rn}\left(\frac{Bq}{m^3}\right) = \frac{C\,\lambda_{Rn}\,h\,t}{l} \tag{6}$$

where, C_{Rn} radon concentrations which culculte by equation ρ/kt, t is the exposure time (90 d), and l is the thickness of the sample in the tube.

The radon activity inside the sample A_{Rn} was obtained using the following formulas:

$$A_{Rn}(Bq) = C_{Rn}\,V \tag{7}$$

$$V = \pi\,l\,r^2 \tag{8}$$

where V is the sample volume in(m^3).

The number of uranium (^{238}U) atoms in the sample N_u at the secular equilibrium can be obtained by podgorsak [19]:

$$N_u = \frac{A_{Rn}}{\lambda_U} \tag{9}$$

where λ_U is the decay constant of uranium (4.9×10^{-18}/s). Therefore, the weight of uranium in the sample M_u in gram can be determined as following [20]:

$$M_u = \frac{M_u\,A_U}{N_A} \tag{10}$$

where A_U is the mass number of (^{238}U) and N_A is Avogadro's number. Thus, the concentration of uranium M_u in (ppm) is given by [21]:

$$C_u(ppm) = \frac{M_u}{M} \tag{11}$$

3. Results and discussion

The results of effective radium activity, radon exhalation rate and uranium in the medical plants samples selected from Iraqi markts are shown in table 2. The effective radium activity ranged between 0.029±0.032 Bq/kg in sample (M6) to 0.327±0.028 Bq/kg in sample (M30) with an average value of 0.142±0.025 Bq/kg. Also from table 2, the radon exhalation rates has been found to vary from 2.287±2.497 μBq/m^2.d in sample (M6) to 25.139±2.210 μBq/m^2.d in sample (M30) , with an normal esteem10.986±1.989 μBq/m^2.d. All results of effective radium activity and radon exhalation rate were smaller to the accordable limit, published by the OECD [22].The uranium concentrations was changed from 0.018±0.002 ppm at test (M6) to 0.202±0.057 ppm at test (M30) with an normal 0.087±0.002

ppm.The contrast within the viable radium movement at this think about is due to the distinction within the fundamental bedrocks and the geology of the examined regions as well because, It is found that, the normal esteem of radon exhalation rate for the ponder range was much less than the normal by UNSCEAR 2000 [12]. The variety in values of radon exhalation rate may be due to the contrasts in radium substance. In this manner, it postures no threat to human wellbeing from the point of see of radiation. The radium activity concentration in table 2 is higher than that of uranium, and thus uranium commitment to the alpha particles emanation is unimportant. Be that as it may, the concentrations of radionuclides within the current consider are much less than those of medicinal plants [23]. Usually since, amid the arrangement forms, the action concentrations of radionuclides are essentially decreased in restorative plant definitions compared to those within the crude plants. The variety in concentrations is likely due to the diverse common presence of uranium deepest plants. The variety in the alpha focuses can be ascribed to the various segments of these examples since they were of plant origin. The contamination that happened by radiation can be additionally specifically caused by the assimilation of radionuclides from the air. The take-up of radionuclides by plant changes depending on the soil crust, the plant itself and the manure. Thusly, the radiation contamination of the plant is profoundly foreseen. The activity concentration of radium changed in the formulations , and that might be credited to that the activity concentrations of radium and different radionuclides were in a state of variation from one soil of cultivation to another, and in addition plants likewise fluctuate in their take-up of radionuclides. Plants might be liable to contamination through numerous elements, for example, compost , coordinate testimony , root take-up, and inundating plants with polluted water. uranium commitment in the outflow of alpha particles is unimportant. This is because, during the preparating processes, the activity concentrations of radionuclides are significantly reduced in medicinal plant formulations with those in the crude plants. The variety in concentrations is probably attributed the difference in natural presence of uranium in many plants.

4. Conclusions

The consider the radium concentration and radon exhalation rate in samples of medical plants tests have been found to be well underneath that constrained by OECD and UNSCEAR 2000, separately. Moreover it is found that, all esteem of uranium concentrations are exceptionally small, hence, it may be chosen that the uranium concentrations in irrelevant. All final, the comes about have uncovered that the radium and uranium concentration within the ponder of therapeutic plants and the related exhalation radon does not effect to human health.

Table 2. Effective radium activity, radon exhalation rate and uranium concentrations in medicinal plants

Sample	C_{Ra}(Bq/kg)	Ex(μBq/m^2.d)	C_U (ppm)
M1	0.230±0.045	17.765±3.510	0.14±0.041
M2	0.243±0.017	18.761±1.319	0.148±0.052
M3	0.155±0.037	12.007±2.895	0.096±0.026
M4	0.094±0.019	7.257±1.525	0.058±0.012
M5	0.101±0.014	7.796±1.127	0.062±0.007
M6	**0.029±0.032**	**2.287±2.497**	**0.018±0.002**
M7	0.117±0.049	9.028±3.781	0.07±0.0104
M8	0.074±0.019	5.717±1.537	0.046±0.007
M9	0.089±0.034	6.908±2.664	0.058±0.009

M10	0.121±0.016	9.356±1.257	0.074±0.009
M11	0.076±0.020	5.896±1.590	0.044±0.002
M12	0.124±0.023	9.566±1.827	0.078±0.003
M13	0.181±0.011	13.937±0.899	0.112±0.018
M14	0.066±0.018	5.145±1.416	0.04±0.011
M15	0.094±0.018	7.257±1.432	0.058±0.009
M16	0.061±0.028	4.739±2.199	0.04±0.007
M17	0.116±0.011	9.005±0.901	0.072±0.010
M18	0.241±0.009	18.582±0.701	0.146±0.017
M19	0.214±0.011	16.540±0.805	0.13±0.031
M20	0.190±0.010	14.702±0.810	0.08±0.010
M21	0.201±0.014	15.545±1.139	0.126±0.011
M22	0.115±0.032	8.862±2.512	0.07±0.010
M23	0.124±0.038	9.585±2.970	0.076±0.015
M24	0.208±0.042	16.081±3.249	0.128±0.036
M25	0.131±0.029	10.108±2.306	0.08±0.011
M26	0.135±0.037	10.452±2.857	0.084±0.019
M27	0.106±0.016	8.186±1.247	0.066±0.013
M28	0.075±0.023	5.801±1.831	0.046±0.005
M29	0.040±0.022	3.118±1.713	0.024±0.002
M30	**0.327±0.028**	**25.139±2.210**	**0.202±0.057**
M31	0.133±0.014	10.291±1.085	0.082±0.009
M32	0.091±0.036	7.063±2.817	0.056±0.015
M33	0.111±0.016	8.576±1.265	0.068±0.013
M34	0.222±0.018	17.153±1.428	0.136±0.025
M35	0.176±0.126	13.551±9.729	0.11±0.008
M36	0.100±0.028	7.718±2.228	0.062±0.011
M37	0.320±0.004	24.657±0.384	0.196±0.036
M38	0.132±0.008	10.184±0.681	0.082±0.018
M39	0.254±0.012	19.603±0.9579	0.156±0.024
M40	0.071±0.028	5.479±2.117	0.046±0.006
Average	0.142±0.025	10.986±1.989	0.087±0.002

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