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Assessment of Annual Effective Dose from ^{226}Ra , ^{232}Th and ^{40}K in Soil - Health Evaluation of Parsley and Leek Based on its Natural Radioactivity in Ilam Province, Iran

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ABSTRACT

There are always ionizing radiation sources in our environment and they can transfer to human being via food chain. Soil-plant-man transfer of radionuclide's to a human being is recognized as one of the major pathway for transfer of radionuclides. The natural radioactivity concentration in soil, parsley, leek samples of Ilam city and also gamma dose rates, external hazard indexes, and annual effective doses due to terrestrial naturally occurring radionuclide's (238U, 232Th and 40K) were calculated based on their activities in samples in Ilam province as determined by gamma-ray spectrometry. In parsley and leek samples, the average activity concentrations of ^{226}Ra , ^{232}Th , ^{40}K and ^{137}Cs were found to be 0.18, 0.34, 178.91, 0.1 and 0.58, 0.2, 171.9,0.02Bq/kg (dry weight), respectively. The D for the areas under investigation at Ilam city for parsley soil samples are 7.86 and in leek soil samples are 7.33nGy/h. H_{ex} and H_{in} in the present work are lower than 1. The average value of H_{ex} was found to be 0.38 and 0.39 and average value of H_{in} to be found 0.38 and 0.39 in parsley soil samples and leek soil samples in Ilam city, respectively. The obtained values of AGDE are 58.18mSv/yr parsley soil samples and 60.02mSv/yr for leek soil samples; the AEDE rate values are 9.40mSv/yr in parsley soil samples and this average value was found to be 9mSv/yr in leek soil samples at Ilam. It can be calculated that no radioactive hazard risk for agricultural fields in Ilam province.

KEY WORDS: Annual effective dose, radionuclide, parsley, leek, soil.

INTRODUCTION

There are many sources of radiation and radioactivity in the environment. The earth and atmosphere contain varied levels from naturally radionuclides such as 238U and 232Th decay chains as well as singly occurring types such as 40K. Soil features,geological formations, and human activities related to radiation and radioactivity are important factors enhancing the background levels of natural radiation(1).

Ingesting and inhaling such levels of radionuclides contribute significantly to the radiation dose that people receive(2). In addition, exposure externally to enhanced levels of radiation can elevate the health hazard risk.
238U and 226Ra are taken into the body through the ingestion of food and water, they tend to deposit in skeletal tissue and on bone surface, respectively.

Although several studies in the literatures present data about the radioactivity in Iranian environmental samples(3-5), no information is available on annual effective dose of 238U and 226Ra from vegetables consumption.

The aim of this study has been to investigate the concentrations of some long lived radionuclides in leek and parsley and also measurements of annual effective ingestion dose in soil for Ilam city inhabitants. These concentrations can be useful as baseline values for the estimation of the internal radiation dose.

MATERIALS AND METHODS

Sample collection and preparation sampling were carried out over the months of November in 2009. 10 samples from parsley soil and 11 samples from leek soil were collected using GPS . Each sampling was being made at a square of 10*10 m^2 to get 2kg weight and saved in a plastic pack. Labeling was done for each pack. To make dry samples were put into oven at 105°C for 24h. Then they were milled. In next step 950 gr of each sample was transffered to Marinelli container with 1000^{cc} volume.

5kg of leek and 3kg parsley samples were taken crushed, dried at 80^0 c for 24 hours to constant weight, sieved of about 1 mm mesh and placed in Marinelli beakers (8). The containers were sealed hermetically so that

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leakage of 222Rn produced from 226Ra decay was negligible. After ensuring secular equilibrium of the progenyof 226Ra and 232Th series by storage for >40 days(10), the sealed samples were ready for analysis.
The activities of 238U, 232Th and 40K were determined using a HPGe gamma-ray spectrometer with 38,5% relative efficiency and 2 keV FWHM for 60Co .

The radiological hazard due to terrestrial radionuclides was estimated using external gamma dose rate, external hazard index and annual effective dose.

The external gamma dose rate in the air at 1 m above ground level was calculated from measured specific activities according to the following equation (1):

$$D = 0.462AU + 0.604ATh + 0.042AK \quad (1)$$

where D is the dose rate in nGy h-1 and AU, ATh and AK are the specific activities (Bq kg-1) of 238U, 232Th and 40K, respectively.
From measured activities of terrestrial radionuclides the external hazard index, Hex and internal hazard index, Hin were calculated:

$$H_{ex} = A_{Ra}/370 + A_{Th}/259 + A_K/4810 \leq 1 \quad (2)$$
$$H_{in} = A_{Ra}/185 + A_{Th}/259 + A_K/4810 \leq 1 \quad (3)$$

where AU, ATh and AK are the specific activities (Bq kg-1) of 238U, 232Th and 40K, respectively. The value of this index must be less than unity to keep the radiation hazard insignificant. The estimated absorbed dose rate was also converted into annual effective dose:

$$AEDE(\mu Sv.y^{-1}) = D(nGyh^{-1}).\ 8766(h/year).\ 0.2\ .0.7(\ sv/Gy).10^{-3} \quad (3)$$

where 0.7 is the quotient of absorbed dose rate in air to annual effective dose received by adults (Sv/Gy) for environmental exposures to gamma rays and 0.2 is the outdoor occupancy factor.
Annual gonadal dose equivalent , AGDE (µSv.y-1) in soil samples were calculated:

$$AGDE(\mu Sv.y^{-1}) = 3.09\ A_{Ra} + 4.18\ A_{Th} + 0.314\ A_K \quad (4)$$

RESULTS

To date, some studies on measurements of radioactivity contents in some Iranian foodstuffs have been conducted. The aim of this study is to determine the annual effective dose from 226Ra and 238U resulting from the consumption of vegetables by inhabitants of Ilam city in Iran. Table 1- 2 show specific activity of the heads of ^{238}U , ^{232}Th radioactive series, ^{137}Cs , ^{40}K isotope in parsley and leek samples.Table 3-4 reveal radiometric results in parsley and leek soil samples.

Tabl-1: Specific activity of the heads of ^{238}U , ^{232}Th ,radioactive series, ^{137}Cs , ^{40}K isotope in parsley sample

Sample Code	Ra-226(Bq/Kg)	Ra-228(Bq/Kg)	Cs-137(Bq/Kg)	K-40(Bq/Kg)
J-1	0.18 ±0.30	0.37± 0.100	0.70 ± 0.20	197.320 ± 7.6
J-2	0.19 ± 0.40	0.39 ± 0.13	< MDA	188.430 ± 7.3
J-3	0.22 ± 0.30	0.36±0. 90	0.30 ± 0. 20	165.060 ± 6.4
J-4	0.15 ± 0.30	0.32 ± 0.15	< MDA	160.740 ± 6.2
J-6	0.14 ±0. 30	0.25± 0.80	< MDA	120.590 ± 4.7
J-8	0.19 ±0. 50	0.29± 0.14	< MDA	181.920 ± 7
J-9	0.26 ± 0.52	0.37± 0.11	< MDA	181.580 ± 7.1
J-10	0.15 ±0. 70	0.24 ± 0.11	< MDA	195.280 ± 7.6
J-11	0.21 ±0. 50	0.38 ± 0.90	< MDA	155.830 ± 6
J-12	0.19 ± 0.40	0.44 ± 0.11	< MDA	242.350 ± 9.3

Tabl-2: Specific activity of the heads of ^{238}U , ^{232}Th ,radioactive series, ^{137}Cs , ^{40}K isotope in leek sample

Sample Code	Ra-226(Bq/Kg)	Ra-228(Bq/Kg)	Cs-137(Bq/Kg)	K-40(Bq/Kg)
T-1	0.90 ± 0.20	0.17 ± 0.50	< MDA	195.640 ± 7.5
T-2	0.11 ± 0.20	0.21 ± 0.50	< MDA	172.490 ± 6.6
T-3	0.11 ± 0.30	0.28 ± 60	< MDA	124.450 ± 4.8
T-4	0.90 ± 0.30	0.10 ±0.70	< MDA	144.630 ± 5.6
T-5	0.90 ± 0.20	0.18 ± 0.80	< MDA	164.410 ± 6.3
T-7	0.21 ± 0.20	0.14 ± 0.50	< MDA	169.250 ± 6.5
T-8	0.60 ±0.30	0.21 ±0.60	0.30 ± 0.10	198.120 ± 7.6
T-9	0.95 ± 0.29	0.26 ± 0.13	< MDA	173.320 ± 6.73
T-10	0.10 ± 0.24	0.16 ± 0.70	< MDA	164.660 ± 6.4
T-11	0.80 ± 0.30	0.18 ± 0.50	< MDA	160.440 ± 6.2
T-12	0.90 ± 0.30	0.33± 0.13	< MDA	223.990 ± 8.6

Tabl-3: Radiometric results in parsley soil samples

Sample Code	D(nGy/h)	AEDE(μSv.y^{-1})	Hin	Hex	AGDE (μSv/y)
SJ-1	8.53	10.46	0.43	0.43	64.06
SJ-2	8.18	10.03	0.41	0.42	61.38
SJ-3	7.2	8.83	0.36	0.36	54.01
SJ-4	7	8.5	0.35	0.35	52.27
SJ-6	5.3	6.5	0.26	0.26	39.34
SJ-8	9	11	0.39	0.39	58.92
SJ-9	8	10	0.41	0.40	59.38
SJ-10	8.3	10.18	0.42	0.41	62.78
SJ-11	7	8.5	0.33	0.34	51.16
SJ-12	10.4	12.76	0.53	0.52	78.53

Tabl-4: Radiometric results in leek soil samples

Sample Code	D(nGy/h)	AEDE(μSv.y^{-1})	Hin	Hex	AGDE (μSv/y)
ST-1	8.3	10.18	0.41	0.41	62.41
ST-2	7.4	9	0.37	0.36	55.37
ST-3	5.4	6.7	0.27	0.27	40.58
ST-4	6.1	7.5	0.30	0.30	46.10
ST-5	7	8.5	0.35	0.35	52.65
ST-7	7.2	8.83	0.36	0.36	54.37
ST-8	8.4	10.30	0.42	0.42	63.27
ST-9	7.4	9	0.37	0.37	55.80
ST-10	7	8.5	0.35	0.35	52.54
ST-11	7	8.5	0.34	0.34	51.37
ST-12	9.5	11.65	0.48	0.48	73

H_{in} Results in parsley soil samples in the area range from (0.26- 0.53) $Bq.kg^{-1}$ with 0.39 $Bq.kg^{-1}$ mean that should be said none of our sample has a high risk value symbol more than 1. H_{in} Results in leek soil samples in the area range from (0.27- 0.48) $Bq.kg^{-1}$ with 0.39 $Bq.kg^{-1}$ mean. H_{ex} Results parsley soil samples in the area range from (0.27- 0.52) $Bq.kg^{-1}$ with 0.38 $Bq.kg^{-1}$ mean that should be said none of our sample has a high risk value symbol more than 1. H_{ex} Results in leek soil samples in the area range from (0.27- 0.48) $Bq.kg^{-1}$ with 0.38 $Bq.kg^{-1}$ mean.The results of AEDE this study respectively are (6.7 – 11.65) $\mu Sv.y^{-1}$ with average9.4 $\mu Sv.y^{-1}$ for parsley soil samples and leek soil samples are (6.5- 12.76) with average 8.96 $\mu Sv.y^{-1}$.

DISCUSSION

The contribution of each radionuclide to the total gamma dose rate varied with sampling location and reflected the geographical origin of the analyzed soils. Terrestrial radioactivity and the associated external exposure due to gamma radiation depend primarily on the geological composition and geographic conditions, and appear at different levels in the soils of each region in the world (6). The specific levels of terrestrial environmental radiation are related to the composition of each lithologically separated area, and to the content of the rock from which the soils originate.

The values of external hazard index obtained in this study, regardless of the location and soil composition, did not exceed the safety limits, pointing out to the insignificant radiation hazard arising from terrestrial naturally occurring radionuclides.

The results of this study are useful as a data baseline for preparing a radiological map of the studied area as well as for enrichment of the world's data bank. Before more definite conclusions of hazards of population exposure to natural radionuclides are drawn, an extended and more systematic survey of the area is needed.

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REFERENCES

1-Colmenero Sujo, L., Montero Cabrera, M.E., Villalba,L., Renter´ıa Villalobos, M., Torres Moye, E.,Garc´ıa Leon, M. Garc´ıa Tenoro, R., Mireles Garc´ıa,F., Herrera Peraza, E.F. and S´anchez Aroche, D.,"Uranium-228 and Thorium-232 Series Concentrations in Soil, Radon-222 Indoor and Drinking Water Concentrations and Dose Assessment in the City of Aldama, Chihuahua, Mexico", Journal of Environmental Radioactivity, 77, 205-219, 2004.

2-Mart`ıze, A., "Medidas de Is´otopes de U, Ra y 210Poen Muestras Ambientales. Programa del Tercer Ciclo de F´ısica Atomica Molecular y Nuclear, Unversidad de Sevilla, 1989.

3-Sohrabi, M., Mirzaii, H. and Hosseini, T. Determination of 226Ra in food samples by a new method using polycarbonate detectors. Radiat. Meas. 25(1–4), 623–624(1995).

4-. Ghiassi-Nejad, M., Beitollahi, M. M., Amidi, J. and Hafezi, S. Natural gamma radiation and public external exposure in Iran. In: Proceedings of the 3rd International WONUC Conference on the Effects of Low and Very Low Doses of Ionizing Radiation on Human Health, Tehran, Iran, 21–24 October (2003).

5-Sohrabi, M., Blourchi, M., Beitollahi, M. M. and Amidi, J. Natural radioactivity of soil samples in some high-level natural radiation in Iran. In: Proceedings of the 4th International Conference on High–level of Natural Radiation, Beijing, China, 1996. Wei, L.,Tsuiomu and Tao, Z., Eds. Radiation Dose and Health Effects (Elsevier Science B.V.) pp. 129–132 (1997).

6- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Sources and Effects of Ionizing Radiation, Report to General Assembly, with Scientific Annexes. New York: United Nations; 2000