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Abstract. Knowledge Expertise of radioactivity levels in the human diet is very important to estimating potential radiological risks to human health. During this research gamma ray spectroscopy technique was used to measure the awareness and amount of the annual effective dose (E_{ave}) due to Uranium, Thorium and Potassium and the lifetime risk factor for cancer (ELCR) in forty samples, of the most widely used medicinal herbs in Iraq and evaluation of ingested doses through herbs consumption, the estimated total annual effective dose received of Uranium, Thorium and Potassium due to the population's consumption of medicinal herbs ranges (0.0124-0.9632) with a mean (0.1502), (0.0024-5.7334) with a mean (0.4750), (0.8324-7.9970) with a mean (2.9349) in units (μSv/y) respectively, while the lifetime risk factor for cancer was ranges (0.0291-0.2798) with a mean (0.1026). All results indicate that they are within the permissible limits for medical and food use, and when comparing the results with IAEA publications and international and Arab research, it was found that they are significantly less than the permissible global range and therefore do not pose a threat to human health also can be considered as database of these herbs in the future.

Keywords: NORMs, herbs, Gamma spectroscopy, Iraq, ELCR.

1. Introduction

All living organisms, including plants, are constantly exposed to ionizing radiation resulting from natural radioactive sources. Therefore, the search for natural radioactivity has always receives great attention, see figure 1. the dose from The natural sources of radiation are the surface of the sun, cosmic rays, radionuclides of terrestrial origin found in the Earth's crust, building materials, water, air, and food of different types as well as the human body itself, the exposure to these nuclides varies greatly according to geographical location and according to food habits but some exposures are almost constant, as ingestion of Potassium-40 in foods. And cosmic rays are more effective at higher places, while Uranium and Thorium concentrations, it increases in local regions. The concentrations of radionuclides differ as a result of the different activities carried out by humans, especially building materials, as well as the ventilation system for homes greatly affects the level of radon gas and its degradation products which contributes greatly by inhaling it [1,2,3]. Medicinal herbs have played an important role in the past decades in human life, and through experience man was able to recognize their properties through their taste, some herbs were found that cause diseases and others treat diseases. The first herbal medical book to appear in China in 2700 BC. The book "The Classic Herbal" was trusted by medicinal herbs. As for the old Babylon, it was, Information relating to plants used in medicine is recorded on mud and stone cylinders, It is estimated that there are more than 350,000 plants in nature, and very few drugs have been scientifically studied for plants, which has led to serious and active active study and

interest in plants, Its side effects are well known [4,5].This seems to be a common problem Where there are a number of studies related to radioactivity in medicinal plants locally and globally using state nuclear track detectors (SSNTDs), and gamma-ray spectrometry such as high purity germanium (HPGe) detector and Sodium Iodide NaI (Tl) detector, but to our knowledge, no study has yielded Ingestion effective dose of medicinal herbs in 40 sample.[4,6,7,8,9,10] the aim of this work is to develop and a continuation of our previous work that studied the activity of Uranium-238, Thorium-232 and Potassium-40 in various models of medicinal herbs in Iraq and given the importance of medicinal herbs in medical treatment and food, where as it was benefiting from that previous work in extraction.[11] this study was conducted to find out Annual Committed Effective dose, risk cancer due in medical herb and the extent of its impact on human health.

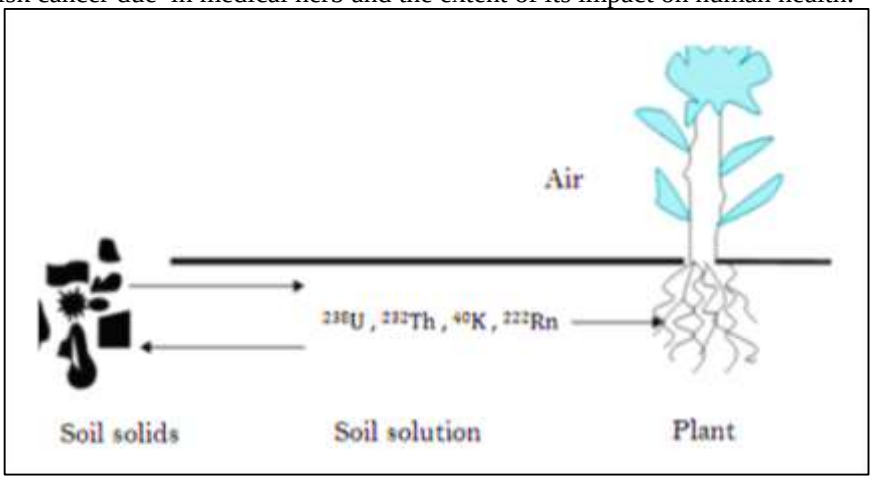

Figure 1. The transport of radioactive elements from the soil to plants

2. Materials and methods

2.1. Collection samples

A total of 40 samples were collected randomly of medicinal herbs used in najaf city, Iraq from the local market and were conducted listed in table 1 according to the originator of each herb, with some medical uses mentioned in table 2.

Table 1. Medicinal herps samples

No	ID	Common name	Scientific name	Part used	Country
1	P01	Ziziphus	*Ziziphus spina-Christi* L.	Leaves	
2	P02	Bepper mint	*Mentha piperita* L.	Leaves	
3	P03	Roselle	*Hibiscuc sabddariffa* L.	Flowers	
4	P04	Myrtle	*Myrtus Communis* L.	Leaves	Iraq
5	P05	Colocynth	*Citrullus colocynthis* (L.) *Shradc*	Fruits	
6	P06	Chicory	*Cichorium intybus* L.	Roots,Stalk &leaves	
7	P07	Aelchenan	*Anabasis*	Leaves	
8	P08	Ginger	*Zingiber officinale* Roscoe.	Roots	
9	P09	Black cumin	*Nigella sativa* L.	Seeds	
10	P10	Grea plantain	*Plantago major* L.	Peel fruits &seeds	
11	P11	Rose-Mallow	*Althaea rosea* L.	Flowers	India
12	P12	Sage	*Salvia Officinalis*	Leaves	
13	P13	Corn Mint	*Mentha hapolcaltt*	Aerial parts	
14	P14	Fenugreek	*Trigonella foenum-graecum* L.	Seeds	

15	P15	Hops	*Humulus Lubulus* L.	Peduncle	Iran
16	P16	Safflower	*Carthamus tinctorius*	Flowers	
17	P17	Blinko	*Ocimumba silicum*	Seeds	
18	P18	Yarrow	*Achillea nillefolium* (Forssk)Sh-Bip	Aerial parts	
19	P19	Alkanet	*Borago officinalis*	Flowers	
20	P20	Flax	*Linum Usitatissimum* L.	Seeds	
21	P21	White cedar	*Thujaoccidentalis*	Fruits	Syria
22	P22	Bay leaves	*Laurus nobilis*	Leaves	
23	P23	Chamomile	*Matricaria chamomilla* L.	Flowers	
24	P24	Balanitea	*Balanites aegyptiaca* (L.) Del.	Fruits	Egypt
25	P25	Horse tail	*Equisetium arvense* L.	Aerial parts	
26	P26	Cyperus	*Cyperus* esculentus	Seeds	
27	P27	Senna	*Cassai senna* L.	Leaves	Saudi
28	P28	African rue	*Ruta chalepensis* L.	Aerial parts	
29	P29	Nutgrass	*Cyperus rotundus L.*	Roots & leaves	
30	P30	Stout bien	*Angelica archangelica* L.	Each herb	China
31	P31	Leaf mustard	*Brasica nigra* (L.) Koch	Seeds	
32	P32	Green tea	*Camellia sinensis*	Leaves	
33	P33	Maidenhair fern	*Abiantum capillus-Veneris* L.	Leaves & Stalk	USA
34	P34	Hawthorn	*Crataegus spp.*	Leaves	
35	P35	Rose of jericho	*Anastatica Hierochuntica* L.	Branches	Palestine
36	P36	Mahleb	*Prunus vinginiana*	Seeds	Azerbaijan
37	P37	Coltsfoot	*Tassilago Farfar*	Leaves & flowers	North Asia
38	P38	Primrose	*Primula vulgris* L.	Flowers	west Asia
39	P39	Sweet marjoram	*Origanum majvrana*	Aerial parts	Middle east
40	P40	Rosemary	*Rosmarinus officinalis* L.	Aerial parts	Mediterranean sea

Table 2. Uses of medicinal herps sample

No	ID	Medicinal uses
1	P01	Relieves muscle pain, joints, soothing nervousness, gums, teeth, asthma and chest problems
2	P02	Joints, rheumatism, antibacterial, reduce blood pressure, calm nerves, get rid of nervousness
3	P03	It reduces blood pressure, strengthens the heartbeat, stimulates digestion, relieves pain
4	P04	Cystitis, gland inflammation, respiratory problems, epilepsy, migraine, appetite suppressant,
5	P05	Intestinal problems, stimulates the work of the kidneys, anti-inflammatory
6	P06	Liver, kidneys, nausea, eye infections, strengthening the heart muscle and blood with iron
7	P07	Dermatology, respiratory disease, diuretic, leprosy, liver disease
8	P08	Relieve rheumatic pain, joints, muscles, headache and anti-inflammatory
9	P09	Cancer, ulcers, diabetes, high blood pressure, kidney infections, skin diseases and colon
10	P10	A good balm to the skin, reduces itching and irritation, sun protection, burn infections
11	P11	Minor wounds and burns, leg ulcers, treat cracks and irritation of the mucous membranes
12	P12	Improve digestive system performance, colic, diarrhea, and reduce blood sugar
13	P13	It fights breast and colon cancer, lowers blood pressure, treats fungal infections
14	P14	Reduces blood sugar, reduces harmful triglycerides, anabolic and milk-producing
15	P15	Anti-bloating, appetite-regulating, digestive, calming nerve, helps sleep
16	P16	Heart disorders, joints and bones, melts thrombosis, lowers cholesterol, stimulates the liver
17	P17	It cleans blood, reduces thirst, gives body vitality, maintains balance, headache, migraine
18	P18	Obesity, infections of the female reproductive system, bone, chest pain, respiratory system
19	P19	It breaks up sand and gravel in the body, treats kidney infections, treats stomach infections
20	P20	Reduces weight, relieves constipation, reduces heart disease, and protects against cancer

21	P21	It protects sensitive areas, vaginal diseases, hemorrhoids, varicose veins, and diarrhea
22	P22	Teeth cleaning, good for heart, blood circulation, improves digestion, diabetes, relieves pain
23	P23	Cold, peptic, calming and analgesic, respiratory infections, skin infections
24	P24	Immunosuppressant, a stimulant for body organs, expelling various waste and impurities
25	P25	Urinary tract infection, kidney and bladder stones, wound healing, fluid retention, gout
26	P26	digestivetreatment, it benefits sexual health, headache, itchy skin and eye diseases
27	P27	Chronic headache, migraine, skin diseases, regulate liver and gallbladder function
28	P28	Worms and gases repellent, blood diseases, damaged hair, uterine diseases, anti-spasticity
29	P29	Fever, headache, cardiovascular disease, lithotripsy, nausea and vomiting
30	P30	Aids digestion, promotes sexual health, good for skin and healthy hair
31	P31	Relieves colds, relieves back pain, joints, rheumatism, infections, and loses appetite
32	P32	StresStimulating the nervous system, improving heart health, preventing malignant diseases
33	P33	Intestinal colic, spleen, bronchitis, impotence, urinary tract, thyroid, anemia, scabies
34	P34	Angina, heart failure, atherosclerosis, hypotensive, migraine pain and cancer prevention
35	P35	Improve fertility for women, uterine diseases, acne, and enlarged prostate
36	P36	Long hair, as well as thickening and strengthening, helps protect it from hair fall
37	P37	Coughing, treating the respiratory system, relieving inflammation
38	P38	Get rid of pimples , acne, prevent skin diseases, delay signs of wrinkles, control blood sugar
39	P39	Brain and head diseases, nervous system stimuli, antispasmodic, coughing, choleretic
40	P40	Prevents blood clotting, tonic for the nerves, anti-inflammatory, depression and spasmodic

2.2. Preparation samples.

After collecting forty samples of herbs available in the Iraqi markets, these samples were put into sealed polyethylene bags and then transferred to the radiation detection and measurement laboratory in the physics department, Education faculty for Girl, university of Kufa ,where a one-liter capacity polyethylene marinelli container was used to store and measure the samples. Before the containers were used, they were washed with dilute hydrochloric acid and then with distilled water. as for the samples, they were sieved with a sieve with a diameter of holes 0.8 (mm) to obtain a homogeneous powder, then dried completely from moisture by keeping them for a period of (6-8) days at a temperature of (40 -42) Celsius. The air is then removed completely from the samples by pressing the vessel with a light light cap of the marinelli beaker. After we place the sample in the container ,the weight of the container and the sample are measured together using the sensitive scale and then we subtract the weight of the container to get the net weight of the sample, then we tightly close the lid of the plastic container with adhesive tape so that radon does not leak (Rn) see figture 2. The sealed containers were kept for a period of 30 days to make sure the samples attained secular radioactive equilibrium between ^{226}Ra and its decay products in the thorium series [6,12].

Figure 2. Samples are inside the marinelli beaker

2.3. Analysis of medicinal herp samples

To determine the concentration of radioactivity for each herbal sample placed on a NaI (Tl) reagent and calculated for 86400 seconds. An empty Counting Marinelli container was also used to calculate the radiological background. The detected gamma lines belong to the primary and main naturally occurring radionuclides ^{238}U and ^{232}Th and the non-sequential ^{40}K natural radionuclides due to poor accuracy of the NaI (Tl) detector, at low gamma energies that do not separate well between the photo-peaks, Therefore, natural radioactivity concentrations can be measured at peaks of good images separated at high energy values as obtained in these results for gamma rays emitted from ^{238}U and ^{232}Th chains that are in a secular equilibrium condition, as well as ^{40}K was estimated directly with the gamma 1460 keV line. Therefore, the specific activity concentration of ^{238}U was determined using the 1765 keV (^{214}Bi) gamma lines. The corresponding results for ^{232}Th were also determined using 2614 keV (Gamma ray lines) (^{208}Tl), an illustrative example of medicinal herb samples from the gamma ray spectrum obtained.On them in Figure 3 [11,13].

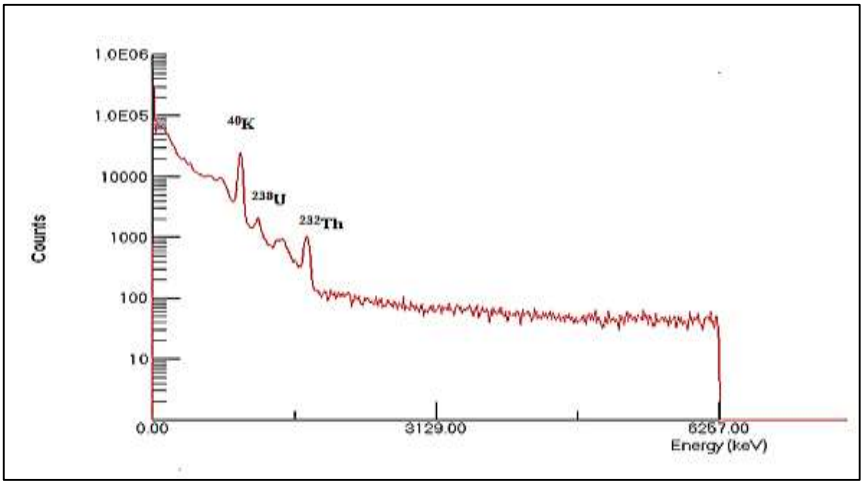

Figure 3. the obtained spectrum in medicinal herbs sample

2.4. Calculation of annual committed effective dose and excess lifetime cancer risk

Concentrations of Uranium, Thorium and Potassium were determined in (Bq/kg) were determined by the following equation [14,6]:

$$A = \frac{N_{count}}{\varepsilon \times I_\gamma \times M \times t} \quad (1)$$

where: A is the radioactivity of measured radionuclides in (Bq/kg), N_{count} is the net count rate, ε is the efficiency of detector to emitted gamma rays, $I_\gamma$is the relative intensity of all gamma energy emitted, M is the mass of the sample in (kg), and t is the counting time of the measurement in (sec) [15].The effective dose as a result of consuming medicinal herbs is very beneficial because of the possibility of collecting different radionuclides that come from different sources, these ingested radiation doses can be measured by measuring the activity concentration (Bq/kg) of radionuclides in herbal medicines from relationship (1), where The effective annual dose equivalent E_{ave} (Sv/y) is calculated by swallowing the radionuclides by the formula (2). [16,17]

$$E_{ave} = \sum_{i=1}^{3} [A_i \times I \times (DCF)_i] \quad (2)$$

Where A_i is Activity concentration of radionuclides in the sample (Bq/kg), I is is the annual intake of medicinal herps (kg/y), DCF is internal dose conversion factor by ingestion of the radionuclides (Sv/Bq), This is given as for ^{238}U, ^{232}Th and ^{40}K (4.5×10^{-8}, 2.3×10^{-7} and 6.2×10^{-9}) in (Sv/Bq) respectively [18,19].

The risks to the population can be estimated by assuming a linear relationship to dose effect with no threshold according to ICRP practice. For low doses, the risk factor for fatal cancer is ICRP 0.05(Sv^{-1}), and the lifetime risk of cancer (ELCR) can be calculated using the following equation [13,16,20]:

$$ELCR = Cd \times RF \quad (3)$$

where: $ELCR$ is Excess Lifetime Cancer Risk, RF is risk factor (Sv/y), Cd is the life time effective dose which is a measure of the total effective dose received over an average lifetime of 70 year following ingestion of a radionuclide was calculated using [13,16,20]:

$$Cd = 70 \times AACD \quad (4)$$

Where: $AACD$ is the average annual commited efective dose.

3. Results and discussion

Given the lack of resources available by UNSCEAR to indicate the amount of daily consumption of adults in Iraq for medicinal herbs, we conducted a questionnaire in several pharmacies, drug stores, and herbal stores, as well as interviewed more than 100 people, so we found that each adult consumes annually an equivalent of 1.7 (kg/y) the results are as follows.

Table 3 shows that most of the doses taken were low for the studied herb samples (ND = not detected), presents the annual effective dose equivalent of ^{238}U, ^{232}Th and ^{40}K radionuclides and the total dose due to the three radionuclides in Iraq medical herb samples estimated and compared with the reported global dose due to ingestion of naturally occurring radionuclide,from Table 3, the annual effective ingestion doses due to intake of ^{238}U varied from 0.0124 (μSv/y) in (African rue) to 0.9632 (μSv/y) in (Grea plantain), the dose received from ^{232}Th due to consumption of medical herb varied from 0.0024 (μSv/y) in (Leaf mustard) to 5.7334 (μSv/y) in (Nutgrass), The values of effective dose from ingestion of ^{40}K ranged from 0.8280 in (Cyperus) to 6.1061(μSv/y) in (Chicory). Thus the contribution to dose from the ingestion of ^{40}K in medical herb with its relatively low dose conversion factor will be much higher than that for the ^{238}U and ^{232}Th. The mean annual effective dose from ^{238}U, ^{232}Th and ^{40}K in medical herb were estimated to be 0.1502, 0.4750 and 2.3095 (μSv/y) respectively. The highest mean annual internal dose was ^{40}K , The total effective dose ranged from 0.8324 (μSv/y) in (Flax) to 7.9970 (μSv/y) in (Nutgrass) with average value of 2.9349 (μSv/y).The low values of effective dose due to intake of medical herb is due to low annual intake of only 1.7 (kg/y) when compared to a few hundred kg/y for the total food intake. The annual effective dose due to ingestion of the natural radionuclides in the medicinal plant samples are far below the world average annual committed effective dose of (0.3 mSv/y) for ingestion of natural radionuclides provided in UNSCEAR [18] report. figture 4 show below the mean annual effective dose distribution in medical herb samples.Finally table 3 shows the calculated cancer risk due to ingestion of medical herb which ranged from 0.0291×10^{-4} in (Flax) to 0.2798×10^{-4} in (Nutgrass) with an average value of 0.1026×10^{-4}, the mean value of ELCR is lower than the world average value of 2.9×10^{-4} based on annual dose limit of (1mSv) for general public by UNSCEAR ICRP [18,19].

Table 3. Ingestion effective dose and ELCR in medical herb

Sample Code	Ingestion effective dose (μSv/y)				ELCR × 10^{-4}
	238-U	232-Th	40-K	Totel	
P01	0.3135	N.D	2.7587	3.0722	0.1075
P02	0.2001	0.1444	2.4724	2.8170	0.0985
P03	0.1822	1.1810	2.9897	4.3529	0.1523
P04	0.0831	N.D	1.6310	1.7141	0.0599

P05	N.D	0.2854	4.6421	4.9275	0.1724
P06	N.D	N.D	6.1061	6.1061	0.2137
P07	0.3388	0.3738	3.0464	3.7591	0.1315
P08	0.2396	1.2401	2.2532	3.7330	0.1306
P09	N.D	0.3705	1.374E	1.7445	0.0610
P10	0.9632	0.8787	1.9715	3.8134	0.1334
P11	N.D	0.5078	3.251E	3.7588	0.1315
P12	N.D	N.D	2.2011	2.2010	0.0770
P13	N.D	0.5301	3.1317	3.6619	0.1281
P14	0.1949	N.D	1.5241	1.7190	0.0601
P15	0.2265	0.2029	1.1467	1.5762	0.0551
P16	N.D	0.1323	2.8934	3.0257	0.1059
P17	N.D	0.5723	1.4372	2.0094	0.0703
P18	N.D	0.3245	3.1259	3.4504	0.1207
P19	N.D	0.2515	4.3137	4.5652	0.1597
P20	N.D	N.D	0.8324	0.8324	0.0291
P21	N.D	N.D	0.9218	0.9218	0.0322
P22	N.D	0.1575	1.4288	1.5864	0.0555
P23	N.D	N.D	3.5725	3.5724	0.1250
P24	0.1519	N.D	1.4120	1.5639	0.0547
P25	N.D	0.6352	4.7349	5.3701	0.1879
P26	N.D	0.5603	0.8280	1.3883	0.0485
P27	0.2741	N.D	1.4746	1.7487	0.0612
P28	0.0124	N.D	1.1483	1.1607	0.0406
P29	0.6801	5.7334	1.5835	7.9970	0.2798
P30	N.D	0.5829	3.9009	4.4838	0.1569
P31	0.0898	0.0024	1.1179	1.2102	0.0423
P32	0.5440	0.7273	1.7654	3.0367	0.1062
P33	0.8775	0.8235	2.5071	4.2081	0.1472
P34	N.D	0.2512	1.2546	1.5058	0.0527
P35	0.2109	0.2803	3.3801	3.8714	0.1354
P36	N.D	N.D	0.8865	0.8865	0.0310
P37	0.3789	0.9346	1.9571	3.2706	0.1144
P38	N.D	1.0711	2.2251	3.2962	0.1153
P39	0.0479	0.2482	1.9607	2.2568	0.0789
P40	N.D	N.D	1.2247	1.2246	0.0428
Range	0.0124-0.9632	0.0024-5.7334	0.8280-6.1061	0.8324-7.9970	0.0291-0.2798
Mean	0.1502	0.4750	2.3095	2.9349	0.1026

ND = not detected

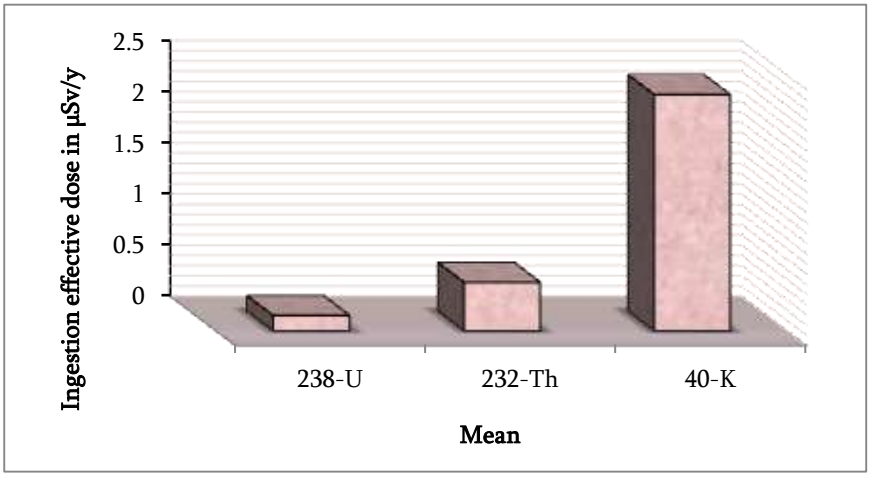

Figure 4. Ingestion effective dose in medicinal herbs sample

4. Conclusions

The study estimated the calculation of the annual effective dose due to ingestion of radionuclides in medicinal herbs that are commonly used by the population in Iraq, where the results were less than the permitted safe value UNSCEAR [18]. and the risk of developing lifelong cancer is very low for safe value and therefore there is no health risk for human health ICRP [19]. In the end, this study finds that Forty forms of medicinal herbs are commonly used in the field of medicine and as a foodstuff that has been sampled safe for radioactive consumption IAEA [21]. We can consider this study on medicinal plants as a database to calculate the annual effective dose and lifetime cancer risk factor for future studies due to the use of a large number of models.

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