Annual Committed Effective dose as a result of daily Consumption of Medicinal Herbs in Iraq

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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 (Eave) 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 herbs 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           | *Hibiscus sabdariffa* 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 | India    |
| 11 | P11 | Rose-Mallow       | *Althaea rosea* L.               | Flowers            |           |
| 12 | P12 | Sage              | *Salvia Officinalis*             | Leaves             |           |
| 13 | P13 | Corn Mint         | *Mentha hapolactt*               | Aerial parts       |           |
| 14 | P14 | Fenugreek         | *Trigonella foenum-graecrum* L.  | Seeds              |           |
| 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 |

Table 2. Uses of medicinal herps sample

| No | ID   | Medicinal uses                                                                 |
|----|------|---------------------------------------------------------------------------------|
| 15 | P15  | Hops *Humulus Lupulus* L. Peduncle                                                 |
| 16 | P16  | Safflower *Carthamus tinctorius* Seeds                                             |
| 17 | P17  | Blinko *Ocimum basilicum* 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 *Thuja occidentalis* Fruits                                             |
| 22 | P22  | Bay leaves *Laurus nobilis* Leaves                                                |
| 23 | P23  | Chamomile *Matricaria chamomilla* L. Flowers                                       |
| 24 | P24  | Balanitea *Balanites aegytiaca* (L.) Del. Fruits                                   |
| 25 | P25  | Horse tail *Equisetium arvense* L. Aerial parts                                   |
| 26 | P26  | Cyperus *Cyperus esculentus* Seeds                                                |
| 27 | P27  | Senne *Cassia senna* L. Leaves                                                    |
| 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                                   |
| 31 | P31  | Leaf mustard *Brasica nigra* (L.) Koch Seeds                                     |
| 32 | P32  | Green tea *Camellia sinensis* Seeds                                               |
| 33 | P33  | Maidenhair fern *Abiantum capillus-Veneris* L. Leaves & Stalk                     |
| 34 | P34  | Hawthorn *Crataegus spp.* Leaves                                                 |
| 35 | P35  | Rose of jericho *Anastatica Hierochuntica* L. Branches                            |
| 36 | P36  | Mahleb *Prunus virginiana* Seeds                                                  |
| 37 | P37  | Coltsfoot *Tassilago Farfar* Leaves & flowers                                    |
| 38 | P38  | Primrose *Primula vulgaris* L. Flowers                                            |
| 39 | P39  | Sweet marjoram *Origanum majvran* Aerial parts                                    |
| 40 | P40  | Rosemary *Rosmarinus officinalis* L. Aerial parts                                  |
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 Digestive treatment, 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 Stress Stimulating 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, choleric
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 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 figure 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].
2.3. Analysis of medicinal herb 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 $^{238}\text{U}$ and $^{232}\text{Th}$ and the non-sequential $^{40}\text{K}$ 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 $^{238}\text{U}$ and $^{232}\text{Th}$ chains that are in a secular equilibrium condition, as well as $^{40}\text{K}$ was estimated directly with the gamma 1460 keV line. Therefore, the specific activity concentration of $^{238}\text{U}$ was determined using the 1765 keV ($^{214}\text{Bi}$) gamma lines. The corresponding results for $^{232}\text{Th}$ were also determined using 2614 keV (Gamma ray lines) ($^{208}\text{Tl}$), 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](image)

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]:

$$A = \frac{N_{\text{count}}}{\varepsilon I_{\gamma} M t}$$  \hspace{1cm} (1)

where: $A$ is the radioactivity of measured radionuclides in (Bq/kg), $N_{\text{count}}$ is the net count rate, $\varepsilon$ 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 $E_{\text{ave}}$ (Sv/y) is calculated by swallowing the radionuclides by the formula (2), [16,17]

$$E_{\text{ave}} = \sum_{i=1}^{3} [A_i \times I \times (DCF)_i]$$  \hspace{1cm} (2)
Where $A_i$ is Activity concentration of radionuclides in the sample (Bq/kg), $I$ 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 ($4.5 \times 10^{-6}$, $2.3 \times 10^{-3}$ and $6.2 \times 10^{-7}$) 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]:

$$ELCR = Cd \times RF$$

(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]:

$$Cd = 70 \times AACD$$

(4)

Where: $AACD$ is the average annual committed effective 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 Iraqi 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 ($\mu$Sv/y) in (African rue) to 0.9632 ($\mu$Sv/y) in (Grea plantain), the dose received from $^{232}$Th due to consumption of medical herb varied from 0.0024 ($\mu$Sv/y) in (Leaf mustard) to 5.7334 ($\mu$Sv/y) in (Nutgrass). The values of effective dose from ingestion of $^{40}$K ranged from 0.8280 in (Cyperus) to 6.1061($\mu$Sv/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 ($\mu$Sv/y) respectively. The mean value of ELCR is lower than the world average value of 2.9 $\times$ 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 ($\mu$Sv/y) | Total ($\mu$Sv/y) | ELCR $\times 10^{-4}$ |
|-------------|-----------------------------|-----------------|-------------------|
|             | $^{238}$U      | $^{232}$Th    | $^{40}$K     |                   |
| 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  | P06  | P07  | P08  | P09  | P10  | P11  | P12  | P13  | P14  | P15  | P16  | P17  | P18  | P19  | P20  | P21  | P22  | P23  | P24  | P25  | P26  | P27  | P28  | P29  | P30  | P31  | P32  | P33  | P34  | P35  | P36  | P37  | P38  | P39  | P40  |
|---|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|   | N.D  | N.D  | 0.3388 | 0.2396 | N.D  | 0.9632 | N.D  | 0.2265 | N.D  | 0.1949 | 0.5723 | N.D  | 0.4750 | N.D  | 0.1575 | N.D  | N.D  | 0.1519 | N.D  | 0.6352 | N.D  | 0.5603 | 0.2741 | N.D  | 0.0124 | 0.6801 | N.D  | N.D  | N.D  | N.D  | N.D  | 0.3789 | 1.0711 | 0.0479 | N.D  | N.D  | N.D  |
|   | 0.2854 | N.D  | 1.2401 | 2.2532 | 0.3705 | 0.8787 | 0.5078 | 2.2011 | 0.5301 | 1.5241 | 0.1323 | 1.4372 | 3.1259 | 4.3137 | 0.8324 | 0.9218 | 1.4288 | N.D  | 1.4120 | 4.7349 | 0.8280 | 1.4746 | N.D  | 1.4746 | 5.7334 | 0.8280 | 1.1483 | 0.0024 | 0.8235 | 0.2515 | N.D  | N.D  | N.D  | N.D  | N.D  | N.D  | 0.7273 | N.D  | N.D  | 0.0280 |
|   | 4.6421 | 6.1061 | 3.0464 | 3.7330 | 1.374E | 1.9715 | 3.251E | 2.9810 | 3.1317 | 1.5241 | 2.8934 | 3.0257 | 2.0994 | 3.4504 | 4.5652 | 0.8324 | 0.9218 | 1.5864 | N.D  | 1.5639 | 5.7349 | 3.1317 | 1.4746 | N.D  | 1.4746 | 5.7334 | 3.1317 | 1.1483 | 1.1179 | 1.7654 | 2.5071 | 1.2546 | 3.3801 | 0.8865 | 0.9346 | 1.9607 | 2.2251 | 0.2842 | 0.2512 | 0.2803 | 0.2512 |
|   | 4.9275 | 6.1061 | 3.791 | 3.791 | 0.7145 | 0.8134 | 3.7988 | 2.2010 | 3.6619 | 1.7190 | 3.0257 | 2.0994 | 3.4504 | 4.5652 | 0.8324 | 0.9218 | 1.5864 | N.D  | 1.5639 | 5.7349 | 3.1317 | 1.4746 | N.D  | 1.4746 | 5.7334 | 3.1317 | 1.1483 | 1.1179 | 1.7654 | 2.5071 | 1.2546 | 3.3801 | 0.8865 | 0.9346 | 1.9607 | 2.2251 | 0.2842 | 0.2512 | 0.2803 | 0.2512 |
|   | 0.1724 | 0.2137 | 0.1315 | 0.1306 | 0.0610 | 0.1334 | 0.1315 | 0.0770 | 0.1281 | 0.0601 | 0.1059 | 0.0703 | 0.1207 | 0.1597 | 0.0291 | 0.0322 | 0.0555 | 0.1250 | 0.0547 | 0.1879 | 0.0485 | 0.0612 | 0.0406 | 0.2798 | 0.1569 | 0.0423 | 0.1062 | 0.1472 | 0.0527 | 0.1354 | 0.0310 | 0.1144 | 0.1153 | 0.0789 | 0.0428 | 0.1026 | 0.0291 | 0.2798 |

**ND** = not detected

**Ingestion effective dose in µSv/yr**

|   | Range | Mean |
|---|-------|------|
|   | 0.0124-0.9632 | 0.0124-0.9632 |
|   | 0.024-5.7334 | 0.024-5.7334 |
|   | 0.8280-6.1061 | 0.8280-6.1061 |
|   | 0.8324-7.9970 | 0.8324-7.9970 |
|   | 0.0291-0.2798 | 0.0291-0.2798 |

**Mean**

![Ingestion effective dose in µSv/yr](image)
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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