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Estimation of Natural Radioactivity of Some Medicinal or Herbal Plants Used in Iraq

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Abstract

Nine medicinal or herbal plants used in Iraq were analyzed to determine natural radioactivity. The radionuclides were determined by Gross alpha, beta and gamma spectrometry Proportional counter + NaI(Tl) detector type(XLB5) and gamma-ray spectroscopy with (HPGe) techniques. The activity concentration of ^{40}K ranged from 124.1 Bq/kg in (Crust sample) to 88.3 Bq/kg in (Chamomile sample), for gross alpha ranged from (N.D.) in (Flax sample) to 0.4 cpm in (Anise sample), while for beta ranged from 5.7 cpm in (Flax sample) to 25.6 cpm in (Latency sample) and for gamma ranged from 0.6 cpm in (Thyme sample) to 5.10 cpm in (Coriander and Flax samples).

Keywords

Medicinal Plants, Alpha Cross, Natural Radioactivity, Beta Cross, Gamma Spectroscopy

1. Introduction

The natural plants which are used for the treatment of living beings are known as medicinal plant. More than five hundred types of medicinal plants are being used as raw materials of drugs. Medicinal plants are unique type of natural product requiring special consideration due to their potential impact on human health. The pharmacological properties of the medicinal plants have been attributed to the presence of active chemical constituents which are responsible for important physiological function in living organisms [1].

Naturally occurring radioactive materials (NORM) are found in every constituent of the environment: air, water, soil, food and in humans. According to the International Food Safety Authorities Network [2] [3], plants used as food commonly have ^{40}K, ^{232}Th and ^{238}U and their progenies. It is expected that likewise would be found

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in plants used for medicinal purpose since plants are the primary pathway of natural radionuclides entering into the human body through the food chain. Radionuclides and their decay products from ^{238}U and ^{232}Th series together with ^{40}K are terrestrial primordial radionuclides, which originated from the earth's crust and are the sources of natural radioactivity in the environment [4].

Human exposure to radiation in the environment is from sources that are widely used in industry, agriculture, as well as for scientific and medical purpose. Traditional medicine involving use of grasses and herbs is the most ancient method of curing diseases [5].

In Nigeria, there is shift of interest to the use herbal medicine for the cure of diverse diseases. Apart from the high cost of procuring available allopathic medicines for treating even common health disorders, other reasons for this shift are inaccessibility of health institutions in the rural or remote locations in the country and the growing awareness of adverse reaction to some allopathic drugs [6].

Herbal or medicinal plant products, in various forms, have been used to treat illness for many hundreds of years on all continents and within cultures across the world. About 70% - 80% of the world populations, especially in the developing countries, rely on nonconventional medicine in their primary health care [7]. An emerging problem in many developing countries is industrial pollution that causes contamination of vegetation with heavy metals, pesticides, or radioactivity [8]. Therefore the medical properties and effectiveness of medicinal plants depend on environmental conditions, which also have a direct influence on their growth in the place of their occurrence and cultivation [9]. Moreover, medicinal plants are not included in the past, possibly because the ingestion of radioactive material through their consumption had been recognized or was considered insignificant. As mankind uses traditional herbal medicine for the treatment of various diseases and aliments, the study of radionuclide concentration in such plants has great significance [10]. The objective of this study is to determine the natural radioactivity presented in some selected medicinal plants commonly used in Iraq and to assess the radiological risk associated with the use of these medicinal plants.

2. Methods and Materials

Gross alpha, beta and gamma spectrometry (Proportional counter + NaI detector) type (XLB5) and gamma-ray spectroscopy with (HPGe) techniques were used to determine the concentrations of the radioactive isotopes ^{40}K, ^{226}Ra and ^{232}Th.

Samples of medical herbs imported to Iraq were collected from the local markets of Iraq, nine types of herbs shown in **Table 1**, each sample was dried and blended until it became powder.

The gross alpha, beta and gamma spectrometry includes gas-flow proportional counters for alpha and beta counting and sodium iodide NaI(Tl) scintillation detector for gamma ray in the same system, using software package type ECLIPS [11]. (100 g) weight of the powdered sample placed in a bowl blanchet made of stainless steel material and into custom place to counting the total alpha, beta and gamma.

The gamma-ray spectroscopy system consists of high purity germanium (HpGe) detector with a relative efficiency of (40%), 1.95 keV energy resolution (FWHM) at energy peak of 1332 KeV of ^{60}Co isotope. A multichannel analyzer (MCA) with 4096 channel was used. A detector shield had a cavity adequate to accommodate large samples. The shield had lead walls with 10 cm thickness lined inside with graded absorber of Cd ~1.6 mm Cu ~0.4 mm.

Table 1. Herbal or medicinal samples investigated in this study.

Samples Codes	Samples Names
S1	Fenugreek
S2	Thyme
S3	Chamomile
S4	Anise
S5	Coriander
S6	Flax
S7	Latency
S8	Berry
S9	Crust

Calibration and efficiency of the system were carried out using multi-gamma ray standard source (MGS-5, Canberra) of Marinelli beaker geometry. A library of radionuclide's which contained the energy of the characteristic gamma emissions of each nuclide was analyzed and their corresponding emission probabilities were built from the data supplied in the software.

Samples were placed in Marinelli beaker sealed off and kept for one month to achieve radioactive secular equilibrium between ^{226}Ra and ^{222}Rn and daughter nuclei.

In order to determine the background distribution due to naturally occurring radionuclide's in the environment around the detector, an empty Marinelli beaker container was counted in the same manner as the samples.

After measurement and subtraction of the background, the activity concentrations were calculated.

Each sample was ground into a fine powder with a particle size <1 mm, 500 gm of each samples were put into standard Marinelli beaker and the activity concentrations for the natural radionuclide's in the measured samples were computed using the following relation [12]:

$$A_{Sp} = N(E,i)/\varepsilon\gamma(E)\cdot Tc\cdot P\gamma(E,i)\cdot M \quad (1)$$

where N(E, i) is the net counts for the radionuclide i at energy E, $\varepsilon\gamma$(E) is the photopeak efficiency at energy E, Tc is the counting live-time (s), Pγ(E, i) is the gamma emission probability of the radionuclide i for a transition at energy E, M is the dry-weight of samples (kg).

The average annual committed effective dose, Eave, for ingestion of NORMS in the medicinal plants was calculated using the expression in equation [13]:

$$E_{ave} = I_p \cdot DCF_{ing} \cdot A_{Sp} \quad (2)$$

where DCF_{ing} is the dose convection factor for ingestion, for each radionuclide (*i.e.*, 4.5×10^{-5} mSv/Bq, 2.3×10^{-4} mSv/Bq and 6.2×10^{-6} mSv/Bq for ^{238}U, ^{232}Th and ^{40}K respectively for an adult) (UNSCEAR, 2000), I_p is the consumption rate from intake of NORMS in medicinal plants and A_{Sp} is the activity concentration in the plant sample.

3. Results and Discussion

Results of gross alpha, beta, gamma and gamma spectroscopy analysis of medical herbals are shown in **Table 2**.

3.1. ^{40}K Activity Concentration

The activity concentrations of ^{40}K have been determined for various medical herbals. ^{40}K (Bq/kg) were ranged from 883.3 ± 85.8 in Chamomile sample to 124.1 ± 9.5 Bq/kg in Crust sample. The maximum level of ^{40}K con-

Table 2. The results of gross alpha, beta, gamma and specific activity of ^{40}K for some herbal samples used in Iraq.

Samples codes	Traditional name	Gross Alpha (cpm)	Gross Beta (cpm)	Gross Gamma (cpm)	Specific activity (Bq/kg) of ^{40}K	Average annual Effective dose (mSv/y)
S1	Fenugreek	0.20 ± 0.14	13.40 ± 1.16	2.40 ± 3.75	231.5 ± 50.6	0.00258 ± 0.00056
S2	Thyme	0.30 ± 0.17	21.90 ± 1.48	0.60 ± 3.71	587.0 ± 44.5	0.00655 ± 0.00049
S3	Chamomile	0.10 ± 0.10	20.90 ± 1.45	1.10 ± 3.71	883.3 ± 85.8	0.00985 ± 0.00096
S4	Anise	0.40 ± 0.20	23.50 ± 1.53	4.30 ± 3.78	498.2 ± 29.7	0.00557 ± 0.00033
S5	Coriander	0.20 ± 0.14	15.60 ± 1.25	5.10 ± 3.79	451.2 ± 34.9	0.00503 ± 0.00039
S6	Flax	N.D.	5.70 ± 0.75	5.10 ± 3.79	171.1 ± 13.0	0.00193 ± 0.00014
S7	Latency	0.10 ± 0.10	25.60 ± 1.60	3.90 ± 3.77	565.8 ± 32.5	0.0063 ± 0.00036
S8	Berry	0.10 ± 0.10	10.80 ± 1.04	2.10 ± 3.69	208.0 ± 15.3	0.00232 ± 0.00017
S9	Crust	0.20 ± 0.14	9.20 ± 0.96	5.00 ± 3.79	124.1 ± 9.5	0.00138 ± 0.00011

centrations were in Chamomile sample (883.3 ± 85.8 Bq/kg). The high activity concentration of Potassium recorded for Chamomile samples differs geographically from one soil of cultivation to another and some plants also may be due to the fact that, the activity concentrations differ geographically from one soil of cultivation to another and some plants also absorb certain elements more than others as presented in **Figure 1**.

3.2. Gross Alpha (cpm)

In all samples the gross alpha in medical herbals were ranged from 0.40 ± 0.2 cpm in Anise sample to N.D. cpm in Flax sample, Latency and Berry samples. The results of gross alpha were shown graphically in **Figure 2**.

3.3. Gross Beta (cpm)

In all samples the gross beta in medical herbals were ranged from 25.60 ± 1.60 cpm in Latency sample to 5.70 ± 0.75 cpm in Flax sample. The results of gross beta were shown graphically in **Figure 3**.

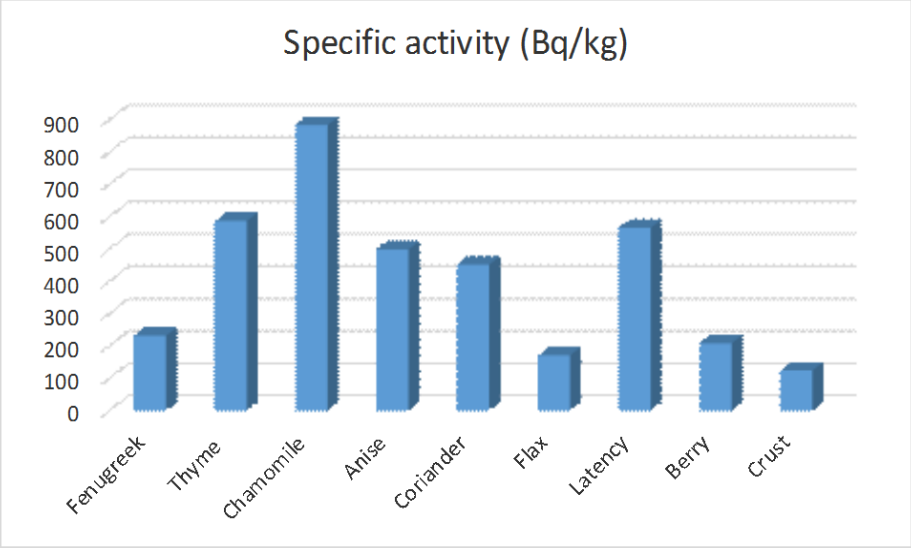

Figure 1. Specific activity (Bq/kg) concentration of ^{40}K for herbal samples.

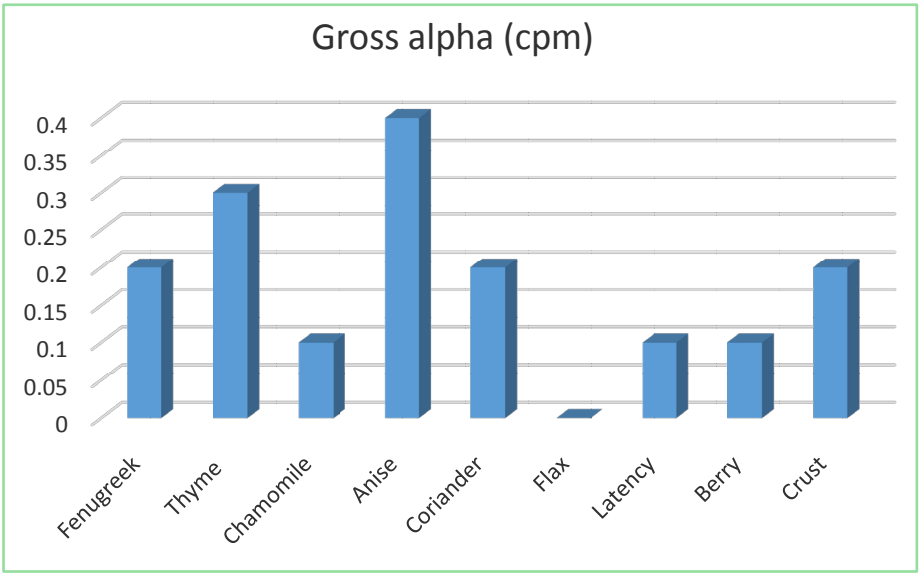

Figure 2. Gross alpha (cpm) concentration for some herbal samples.

3.4. Gross Gamma (cpm)

In all samples the gross gamma in medical herbals were ranged from 5.10 ± 3.79 cpm in Coriander and Flax samples to 0.60 ± 3.71 cpm in Chamomile sample. The results of gross gamma were shown graphically in **Figure 4**.

3.5. Average Annual Committed Effective Dose in the Medicinal Plants

The average annual committed effective doses due to the ingestion of ^{40}K in the medicinal plant are also presented in **Table 2**. The average annual committed effective dose varied from 0.00138 ± 0.00011 to 0.00985 ± 0.00096 mSv/y with an average of 0.00046 ± 0.00026 mSv/y. The highest average was recorded for Chamomile whiles Crust and Flax samples had the lowest. **Figure 5** shows the average annual effective dose distribution in the medicinal plant samples.

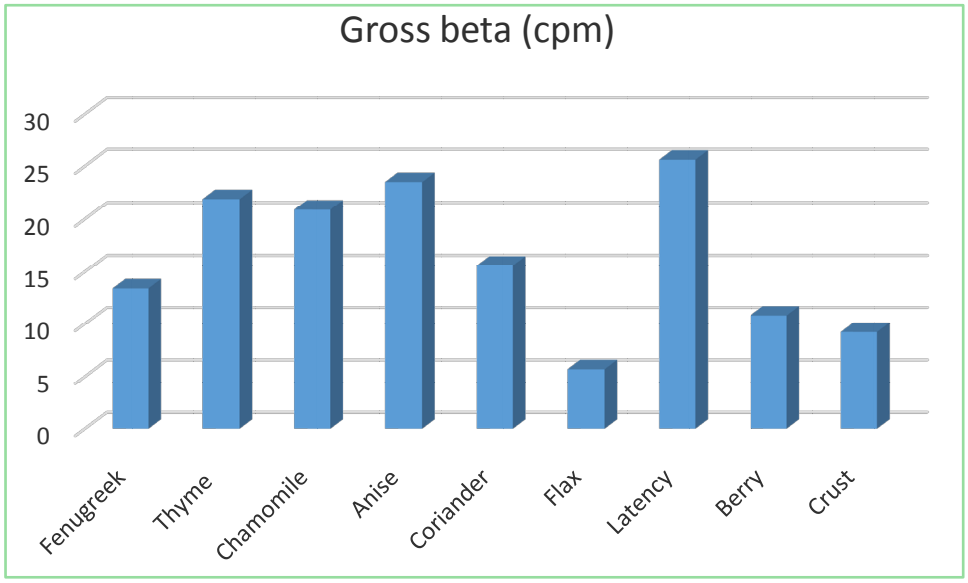

Figure 3. Gross beta (cpm) concentration for some herbal samples.

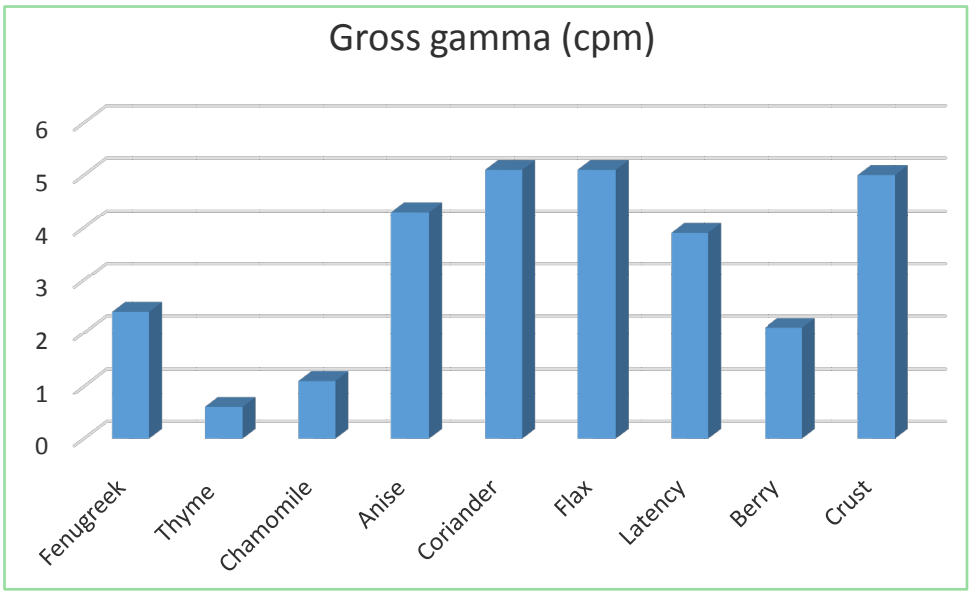

Figure 4. Gross gamma (cpm) concentration for some herbal samples.

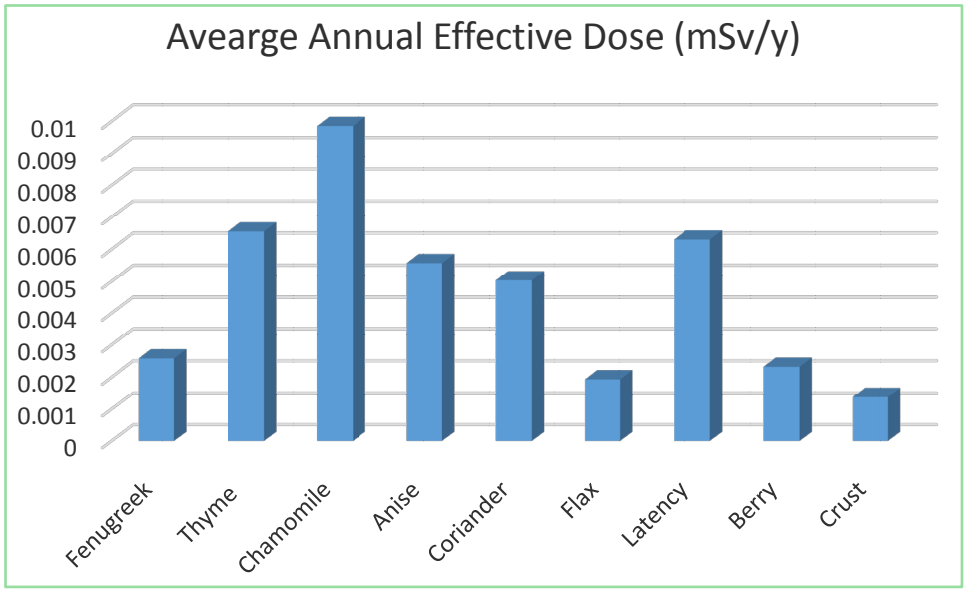

Figure 5. Average annual committed effective dose (mSv/y).

The calculated average annual effective dose to any individual in the population group due to the ingestion of natural radionuclides in the medicinal plants is below the average radiation dose of 0.3 mSv/y received per head worldwide (UNSCEAR, 2000).

4. Conclusions

The average activity concentration obtained for ^{40}K obtained in this study (431.35 Bq/kg) is less than other values of ^{40}K in other studies [3] [14]. Results of gross alpha, beta and gamma are slightly low.

The corresponding average annual effective dose determined in this study to any individual's organ or tissue in the population group due to the ingestion of natural radionuclides in the medicinal plants is far below the average radiation dose of 0.3 mSv/y received per head worldwide due to the ingestion of natural radionuclide (UNSCEAR, 2000).

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