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Distribution pattern of Natural Radioactivity Levels and Radiological Risk in Grasses Samples in Al-Meshal, Libya.

Areej Ibrahim Hazawi [1], Rasha Y.M. Elfallah [2*], Asma M. Abdulrahman Alabrdi[3] and Mabrouka A. Abd-Ahamid[4]

[1,3] Physics Department, Faculty of Science, Omar Al-Mukhtar University, El-beida,Libya
[2,4] General Department, College of Medical Technology, Derna, Libya

[*]Corresponding author: rashaelfallha@gmail.com

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Abstract:
Radioactivity can be found in different degrees in the environment, Terrestrial gamma radiation is one of the major outdoor radiation exposures to the general public, depending on the activity and concentration of the radionuclides being handled, the main concern being exposure to natural radioactivity doses and external exposure rate. This research presents a measurement of the natural radioactivity of Ra-226, U238-, Th232- and K40- for 8 grasses samples around one of the old weapons warehouses located in the Al-Meshal, Libya, using a sodium iodide (NaI) detector. The results showed that the concentration of radioactivity for 238U ranges from [(65.32±6.06) to (85.59±6.77)] Bq/Kg. The mean activities of 226Ra ranges from [(60.02±0.13) to (84.03±0.13)] Bq\Kg, for 232Th ranges from [(66.09±3.07) to (86.42±1.30)] Bq/Kg. For 40K ranges from [(424.42±14.78) to (484.49±18.24)] Bq/Kg, all samples were found to be slightly higher than the world average values 20 ,50, 15, and 420 Bqkg−1, respectively. for uranium, radium, thorium and potassium (UNSCEAR 2010). For Radiological risk (radium equivalent, internal and external hazard indices), it was found that these samples have lower or within the recommended limits internationally.

Keywords: Radioactivity, Sodium Iodide (NaI) Detector, Radium Equivalent, Radiological Risk, External Hazard

Introduction

Humans are exposed to radiation in the environment from a variety of sources, including soil, rocks, water, and plants. The amount of radiation that humans are exposed to varies depending on the concentration of radionuclides in the area. Direct exposure results from external dirt during agriculture, accidental consumption of soil particles, and usage of soil in construction materials. The decay chains of uranium, potassium, and thorium are the primary sources of natural radioactivity. Indirect exposure happens both when breathing in air and when it is absorbed by plants, which humans regard as a food source (HAZOU, 2021). Understanding the radiation levels in our environment is crucial because of the possible consequences on our health and and places of employment. Large dosages of ionizing radiation are dangerous. Soil, which accumulates radioisotopes at different levels, is the primary source of man's continuous exposure to internal or external ionizing radiation (Onudibia et al., 2020). and places of employment. Large dosages of ionizing radiation are dangerous. Soil, which accumulates radioisotopes at different levels, is the primary source of man's continuous exposure to internal or external ionizing radiation (Onudibia et al., 2020).

Material and Methods

2.1. Study area

Al-Meshal is a rural agricultural region located in north-east Libya, with geographical coordinates of (21o 40\ 42.2\\ E, 32o 28\ 46.7\\ N), characterized by fertile soil suitable for agriculture and livestock breeding. The main activity of this region is raising livestock, which contributes greatly to the local production of country, so it necessary to know the environment of this region, including soil, rocks and grasses. Show the geographical location of the search area using Google Earth, using GPES **Figure 1** .

Figure 1 The geographical location of the search area using Google Earth

2.2. Sampling and preparation

The samples were dried using an oven at about 150°C. The samples were manually ground into a fine powder using agate mortar and pestle, The tools were washed with water and sterilized after each sample was ground to further prevent contamination. The ground samples were sieved through a test sieve with an aperture of 250 µm to achieve the greatest possible homogeneity and to prevent low concentration associated with large samples. About 200 g of the dried sample was weighed balance and packaged for laboratory.

Al-Meshal area has fourteen stores of old weapons. One of these stores was chosen to take samples from the four directions (East, West, North and South) for first kilometer of grasses (GW1) applied to all directions in the same way. After the distance of the second kilometer also (GW2), and thus we get samples (8) Grasses as table 1.

Table 1 Description of the samples

SN.	Model Type
GE1	Grasses from the first kilometer (East).
GE2	Grasses from the second kilometer (East).
GN1	Grasses from the first kilometer (North).
GN2	Grasses from the second kilometer (North).
GS1	Grasses from the first kilometer (South).
GS2	Grasses from the second kilometer (South).
GW1	Grasses from the first kilometer (West).
GW2	Grasses from the second kilometer (West).

2.3 Gamma spectrum analysis

The sodium iodide (NaI (Tl)) (3" X 3") detector used in gamma spectroscopy was fully insulated by a lead shield and tuned for a duration of 3600 seconds. used to measure the amounts of NORM in samples of powdered barley. Each sample weighs 0.25 kg. Radionuclides daughter was chosen to determine radioactivity concentration for two series of 238U and 232Th, where nuclide 226Ra was chosen to indicate the radioactivity for a series of 238U, which have been determined through radioactive isotope 214Pb (352keV), due to the low energy resolution efficiency of the NaI (Tl) detector. Additionally, the activity concentration for the 232Th series was calculated using 228Ac (92, 209.5, 338.5, 911.1, and 968.9) keV. The detector can directly detect 40K (1460keV) (Asma., 2023).

2.4. Measurement of activity concentration

The measurement of activity concentrations of Raduim-226, Uranium-238, Thruim-232, and Botasum-40K was carried out with Gamma-ray Spectrometer sodium iodide (NaI) detector. Eigth (8) samples were analyzed for this work the samples were sealed and stored for 30 days prior to analysis to allow for attainment of secular equilibrium between Ra-226 and its decay products. Prior to the sample analysis, background gamma radiation at the laboratory was measured with an empty sample container under similar environmental conditions. The background value was later subtracted during the computation of the activity concentration. The samples were counted for (7200 s).

2.4.1 determine activity concentration

The calculated activity concentration in Becquerel per kilogram C (Bq/kg) was calculated by gamma-ray spectrometry with the measured as the following equation (Jibiri et al. 2014):

$$\mathbf{C} = \frac{\textbf{Net area (CPS)}}{\mathbf{I_{\gamma} \times \xi \, .M}}$$

Where ε is the calculated efficiency for each photo peak energies and M is mass of sample in kilogram, Net area (cps) is the net detected counts per second corresponding to the energy and I_{γ} is the Intensity of the gamm spectral.

2.4.2 Radium Equivalent Activity (Ra_{eq}).

Equivalent activity of radium is the gamma production (Ra-eq) in Bq/kg was calculated by (Alnagran, 2022; Adagunodo et al., 2018) as:

$$\boldsymbol{Ra - eq = Ac_{Ra} + 1.34\, Ac_{Th} + 0.77\, Ac_{K}}$$

Where Ac_{Ra}, Ac_{Th} and Ac_{K} are the activity concentrations for ^{226}Ra,^{232}Th and ^{40}K respectively. The maximum value of Ra_{eq} must be less than 370 Bq/kg.

2.4.3 External Hazard Index (H_{ex}).

The outdoor and indoor radiation dangers are represented by the Hex and Hin indices, and it can be used to regulate indoor exposure to 222Rn and its radioactive off spring (Isinkaye & Oyedele, 2014). The external hazard index resulting from samples of gamma-ray emissions and radiological danger is computed using the relation (I. U. Khan, 2020) :

$$\boldsymbol{H_{ex} = Ac_{Ra}/370 + Ac_{Th}/259 + Ac_{K}/4810 \quad \leq 1}$$

Where Ac_{Ra}, Ac_{Th} and Ac_{K} are the activity concentrations for ^{226}Ra,^{232}Th and ^{40}K in Bq/Kg, respectively.

2.4.4 Internal Hazard Index (H_{in}).

Internal hazard index signifies the radiological hazard due to radon and its daughters; it is the internal radiation exposure related to radioactivity and is expressed as:(Khalda T, et al, 2021):

$$\boldsymbol{H_{in} = Ac_{Ra}/185 + Ac_{Th}/259 + Ac_{K}/4810} \qquad \leq 1$$

Where Ac_{Ra}, Ac_{Th} and Ac_{K} are the activity concentrations for ^{226}Ra,^{232}Th and ^{40}K in Bq/Kg, respectively. According to **Diab et al, 2008** the values of the indices (H_{ex} and H_{in}) must be less than 1 for radiation hazard to be negligible.

Results and Discussion

The values of activity concentrations for grasses samples varied from [(60.02±0.13) to (84.03 ± 0.13)]Bq/kg, [(65.32 ± 6.06) to (85.59 ± 6.77)]Bq/Kg, [(66.09 ± 3.07)to (86.42 ± 1.30)] Bq/Kg and [(424.42 ± 14.78) to (484.49 ± 18.24)] Bq.Kg-1 for 226Ra, 238U, 232Th and 40K respectively, with average (72.22, 75.42, 76.42 and 452.72) Bq/Kg for all radionuclides 226Ra, 238U,232Th and 40K. The activity concentration of studied grasses samples are higher than the permissible level for radium (50 Bq.Kg-1) (UNSCEAR 2010), the activity concentration are higher than the permissible level for uranium (20 Bq.Kg-1) (UNSCEAR 2010), the activity concentration are higher than the permissible level for thorium (15 Bq.Kg-1) (UNSEAR 2010), and the activity concentration are higher than the permissible level (420 Bq/Kg) for potassium [UNSEAR 2010), as show of **table(2)** and **Figure 2**

Table 2 the activity concentration of samples

Samples	226Ra	238U	232Th	40K
GE1	60.73±0.13	70.81±6.09	73.12±4.09	463.89±17.84
GE2	60.02±0.13*	65.32±6.06*	66.09±3.07*	429.83±17.17
GN1	73.43±0.13	75.62±6.45	76.83±1.05	450.17±17.58
GN2	69.91±0.13	74.81±6.43	75.07±4.44	424.42±14.78*
GS1	84.03±0.13**	85.59±6.77**	86.42±1.30**	484.49±18.24**
GS2	72.03±0.13	73.65±65.81	70.25±1.19	433.26±16.69
GW1	79.09±0.13	80.26±6.54	82±1.41	473.51±18.03
GW2	78.38±0.13	79.88±6.54	81.57±4.66	461.15±17.79
Average	72.22	75.63	76.42	452.72
P. L	50	20	15	420

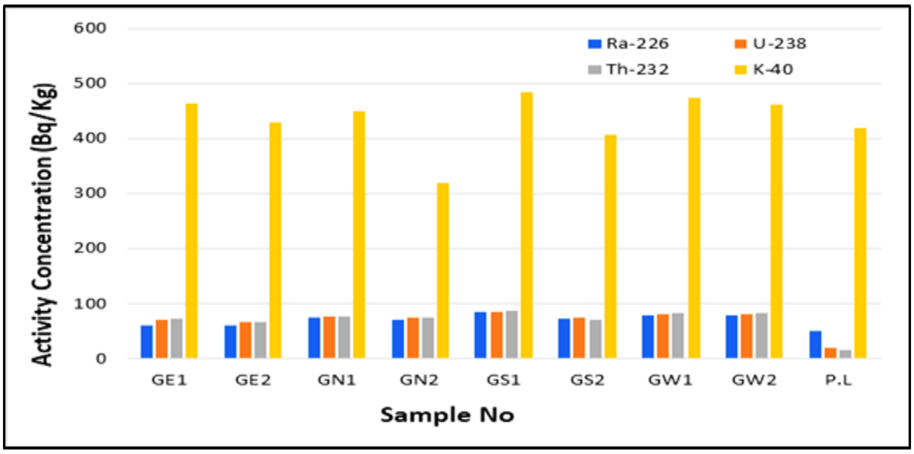

Figure 2 The Activity Concentration of 226Ra, 238U, 232Th and 40K in the Grasses Samples.

The internal hazard results were obtained and shown in Table. The value of H_in of grasses samples ranged from (0.67 to 0.89), with an average value 0.78, as shown of **Figure 3**. All values of internal hazard for the studied grasses samples are lower than unity (UNSEAR 2010).

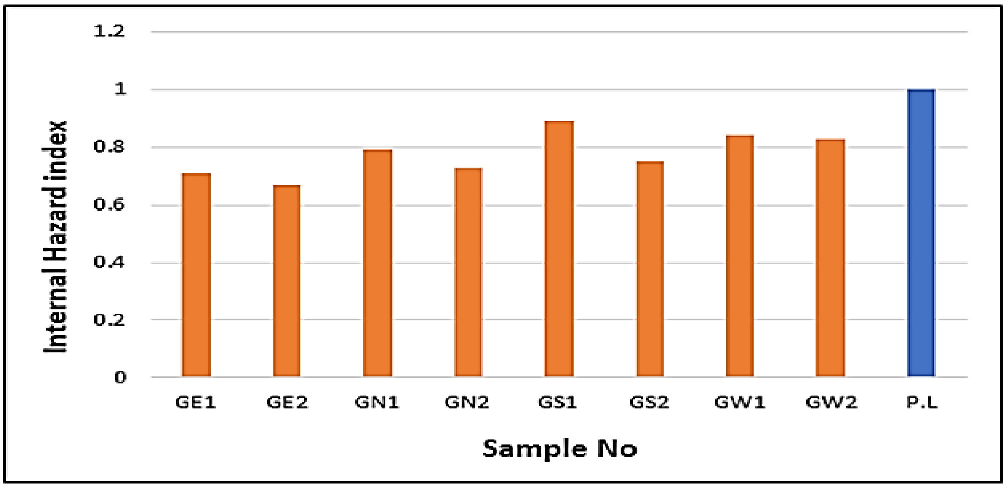

Figure 3 Internal Hazard Index of Grasses Samples.

The external hazard results were obtained and shown in Table. The value of H_ex of grasses samples ranged from (0.51 to 0.66), with an average value 0.58, as shown of the **Figure 4**. All values of external hazard for the studied grasses samples are lower than unity (UNSEAR 2010).

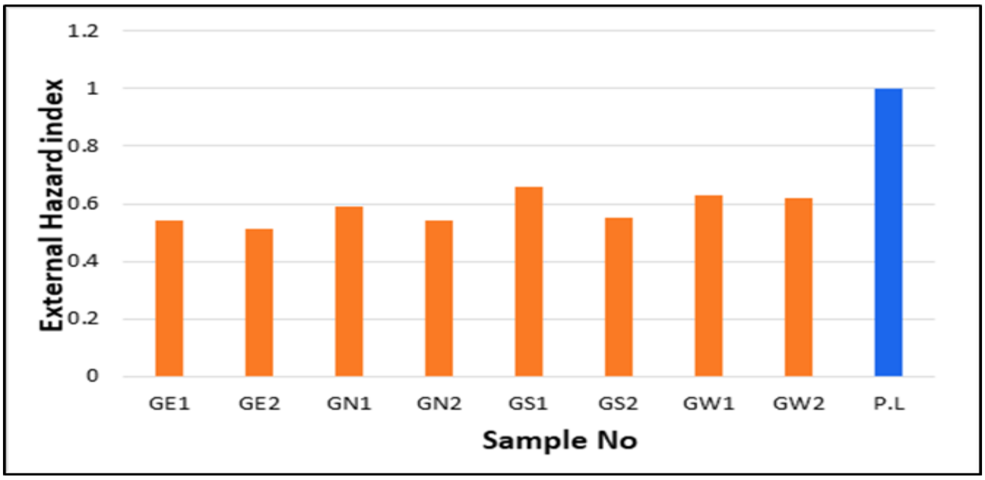

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Figure 4 External Hazard Index for Grasses Samples

Conclusion

- A gamma ray spectrometry system with a Na(Tl) detector was used to assess the activity concentration of radionuclides 226Ra, 232Th, 238U, and 40K as well as their radiological risks for eight grass samples
- In this investigation, the activity concentrations of the grass samples under study exceed the permissible level for radium, the permissible level for thorium, the permissible level for uranium, and the permissible level for potassium.
- The studied grasses samples had radium equivalent values below the world recommended value of (370 Bq/Kg).
- The measured values of external hazard index $\mathbf{H_{ex}}$ of are lower grasses is lower (the recommended value). For all studied samples, the measured values of internal hazard index $\mathbf{H_{in}}$ were lower than unity for grasses is lower (the recommended value)

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