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Radionuclide Levels in Soil, Root, and Plant Samples from Al-Dora Refinery

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Abstract

Measurement of the levels of naturally occurring radionuclides deposited in the AL-Dora Refinery. Five samples were selected from various locations. Root, plant, and soil. uranium, thorium, 40K, and 137Cs have been used to calculate the radionuclide content of gamma emitters. Error percentages were computed. The following list of particular actions for the radionuclides under study: The largest concentration of pollutants was in Cs137 (35%) > Th232 (34%) > U238 (20%) > K40 (11%); gamma spectrometry was employed to assess the activity concentration of the radioelements. The average concentrations were maximum accumulation in plant and root reaching 35% and 32%, respectively. The radionuclide that accumulates the greatest in plants, particularly in their leaves were 238U (58-15 Bq/kg), 232Th (45-21 Bq/kg), 137Cs (46.47-18.68 Bq/kg), and 40K (9.5-4.82) Bq/kg compared with root samples reached the highest concentrations of 238U (29-14 Bq/kg), 232Th (44-25 Bq/kg), 137Cs (52.6-23.25 Bq/kg), and 40 K (18.4-19.9-184 Bq/kg). in general; Particularly in tropical regions near the refinery, a safety evaluation of transport pathways and radioactive buildup in soils with potential for agriculture is crucial.

Key words: AL-Dora Refinery, radionuclides, Natural radionuclides

Introduction

The Al-Dora Refinery is one of Iraq's oldest and largest oil refineries. It is located in southern Baghdad and produces 140,000 barrels per day. It receives oil from the Kirkuk and Khanaqin governorates' fields [1]. According to environmental and international rules, an Iraqi parliamentary committee has recommended the transfer of a major oil refinery near the town of Dora to another area. The Dora region was not populated when the refinery was created around the close of the 20th century. Concerns regarding the refinery's influence on the community began in 2014 [2]. There are various levels of natural radionuclides, commonly referred to as terrestrial or primordial radionuclides, in the earth's crust (rocks and soil). The thorium (Th232) and uranium (U238) series, as well as non-series natural radionuclides like Rb87, K40, La138, and Sm147 decay as well as Lu176, are categorized as terrestrial radionuclides [3], when it comes to the decay radionuclides in the atmosphere. The environment is filled with uranium and thorium series radionuclides naturally [4]. They may be discovered in the human body as well as in food, water, rocks, soil, and rocks[5]. a parent is Lead is the last (stable) element in both of the complex series of radioactive elements U238 and Th232. Naturally occurring radioactive materials (NORM) may be discovered in a number of industries, including the oil and gas sector. Petroleum reservoirs, oil and gas extraction facilities, and processing facilities may all include NORM [6,7,8]. Hassan and Mahdi[9] gathered soil samples in Baghdad to assess radioactivity and find nuclides using HPGe. They found that the specific activity rates of Th232 , and Cs137, respectively, were 13.84 Bq/kg, 15.76 Bq/kg, 288.39 Bq/kg, and 1.56 Bq/kg, were all within the global normal range. Muhammad and Hassoun [7] investigated the number of radioactive elements in six kinds of soil in the Al-Ruhban region of the fief of Najaf, using HPGe. They discovered that the standard of concrete radioactivity of the nuclides Cs137, Ra226, Th232, K40, Ac228 and, Bi214 were (126.3, 5.03, 1.63, 81.87, 47.93). Also, Al-Gazaly et al[8] calculated the specific radioactivity values of Th232, U238, and K40 soil samples obtained from Najaf-Abu-Sakhir, Iraq, and discovered that potassium and uranium concentrations were higher than the global average. Almayahi [9] studied the radioactivity rate of U238, Th232, and K40 about 78, 78, and 286 Bq/kg using a NaI (Tl) sensor and found that the equivalent radioactivity was equal to 246 Bq/kg, which is below the 370 Bq/kg level that has been universally accepted. Dashty and Ali [10] used the NaI sensor to assess the radioactivity of Ra226 in Kurdistan, Iraq, which ranged as 8.10 - 22.40 Bq/ kg compared to the worldwide average of ≤ 30 Bq/kg. Rhizodegradation, also known as phytostimulation, is the breakdown of organic substances (fuels and solvents) into plant nutrients in the rhizosphere by microbial (fungi, yeast, bacteria, and other microorganisms) activity[11]. This approach is so frequently used in soil treatment that rhizoremediation has a more than 100-year history in Germany. Plant exudates, such as carboxylic acids, amino acids, and carbohydrates, can promote rhizosphere microbial activity and speed up the rhizodesgradation process[12]. Metal ions are transported from the bulk soil to the plant root zone via two methods. The movement of ions is driven by convection, or mass flow, and diffusion. Roots absorb certain ions at a quicker pace than they are supplied, resulting in a depleted zone next to the root[13]. Convection or mass flow transports soluble metal ions from soil solids to the root surface. Cynodon dactylon is a plant. It has a deep root system that may grow to depths and over 3 metres in drought conditions; nonetheless, the majority of the root mass is less than 70 cm under the soil's surface The lawn Because of the capacity of the roots to produce nodes, it develops a thick mat as it crawls along the ground, whenever they come into contact with the earth. Cynodon dactylon roots from the rhizosphere restore water that has been lost to the plants due to transpiration. They are capable of absorbing water[14]. A hydraulic gradient extends from the bulk soil to the root surface as a result of water ingestion in the rhizosphere. Due to the difference in concentration created between the bulk soil solution and the adsorbed elements, soil particles are kept in touch with the elements via the solution[15, 16, 17]. The current study's goal is to use a gamma spectrometry system to measure the levels of naturally occurring radioactivity and calculate risk indices, such as radium equivalent activities, representative level index, external and internal hazard index, absorbed dose rate, and effective dose rate in the crude soil and plant (leaf, root) in the AL-Dora Refinery.

Material and Methods

Regions around the AL-Dora Refinery in Iraq and supplied a portion of Cynodon dactylon roots to the populace (Fig. 1). Cynodon dactylon's soil samples were collected from every place and investigated up to a depth of 10 cm to determine that the adventitious root system only extends in the top layer of the soil and does not penetrate deeper. Soil samples from three to four locations within a single subsection were combined, to construct a composite sample representative of that section, the material was dried, sieved, and homogenized. Three pieces of dirt, each weighing about one kilogram, were collected from this complicated sample for additional examination, and their average activity was recorded as one sample. around 20 to 30 altogether Plants with Cynodon dactylon roots. In order to construct a composite sample that is representative of that area, soil samples were taken from three to four different locations in a single sub-section and then mixed, dried, sieved, and homogenized. From this complex sample, three pieces of around one kilogram of soil were taken for further analysis, and their average activity was recorded as one sample. Similar to that, 20 to 30 completely mature Cynodon dactylon were collected from each region of the chosen farms and split into Cynodon dactylon. For 48 hours, samples of soil and Cynodon dactylon (plants) were dried in a 100°C oven. In order for soil samples to pass through an 80 mesh (0.5 mm opening) screen, they were powdered. On the other hand, plant samples were pulverized to fit through a 100-mesh screen. Ground samples were kept in hermetically sealed containers for radioassay and other pertinent tests.

For radio experiments, gamma-ray spectroscopy, a multi-channel analyzer (MCA) with an 8192-channel capacity, and a high efficiency (40%) high purity germanium radiation detector were employed. The analytical tool Giene-2000 was used to analyse the obtained findings. The CO60 Eu152 radiometric source was used to calibrate the Gama Spectrometer.

Using information from UN Scientific Committee studies on the industrial elements 137Cs and the elements 40K, 226Ra, 214B, and 212Pb, as well as Gamma rays produced by uranium, thorium, and potassium decaying spontaneously were calculated.The data on radioactivity concentrations in soil and grains from one field were compared to those from the other field using a student's t-test with a 99% confidence level to determine the significance of the variances in their mean values.

Results and Discussion

Oil extraction activities, such as fracking, drilling, and production, can result in the emission of radioactive elements, putting employees, local communities, and the environment at risk. Many soils and rock formations, as well as the water that runs through them, naturally contain radioactive materials. Significant quantities of these radioactive elements can be released into the environment as a result of oil exploration and production activities [10, 13].

Rhizodegradation is the growth of plants that have the potential to use their metabolic processes to change dangerous pollutants into harmless byproducts. Figure 1 shows the highest concentrations of 238U (29-14 Bq/kg), 232Th (44-25 Bq/kg), 137Cs (52.6-23.25 Bq/kg), and 40K (18.4-19.9-184 Bq/kg); specific activity in Bermuda grass (Cynodon dactylon) were discovered in sites 5, 1, and 2, respectively, reaching 28%, 25%, and 20%; whereas the lowest concentrations of 238U, 232Th, 137Cs, and 40K in Bermuda grass plant were found in sites 3 and 4, respectively. Bermuda grass had 40%, 35%, 12%, and 13% of the capacity to metabolize in 137Cs>232Th>238U>40K, respectively.

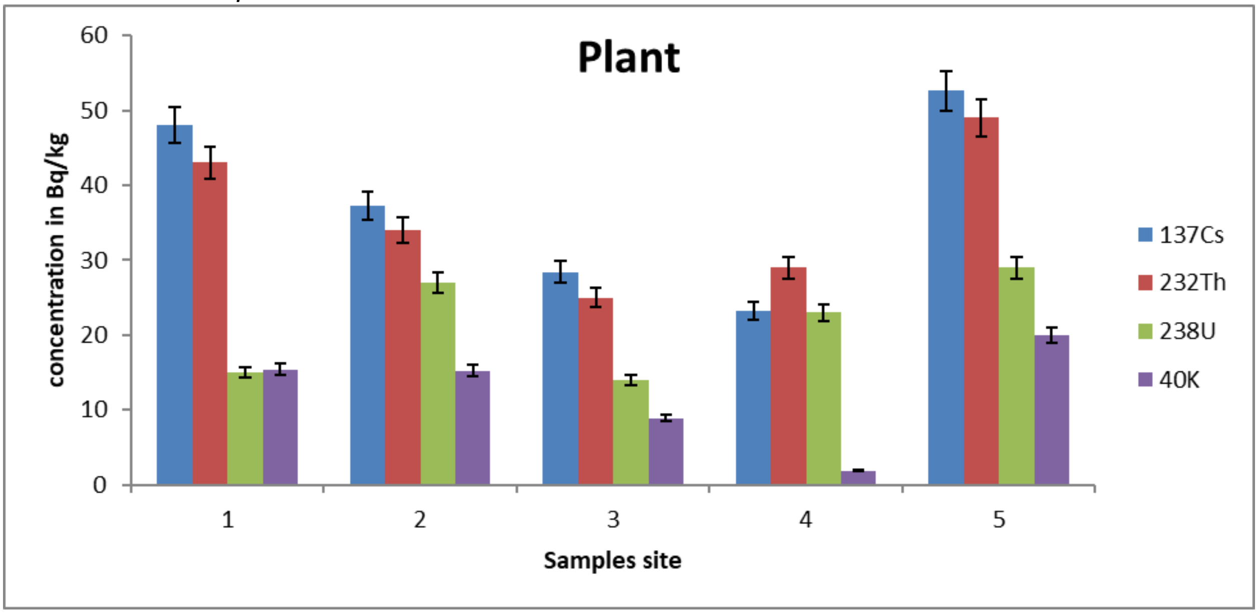

Figure (1) shows the specific activity owing to ^{238}U, ^{232}Th, ^{137}Cs and ^{40}K in plants sampled from all of the AL-Dora Refinery.

By creating a favorable habitat for microbial degraders and encouraging them via root exudates, the plant serves as a booster for their growth. However, the Bermuda grass can rhizoremediate natural radioactivity (238U, 232Th, 137Cs, and 40K) vales reached 28% in site 1; 24% in site two; 19% in site two; 18% in site five; and 19% in site two (Figure 2). Overall, this highlights the distinct roles of the root of Bermuda grass the amount of naturally occurring radioactive 232Th that was rhizoremediated by Bermuda grass was 25%; 137Cs was 23.25%; 40K was 18.4%; and 238U was 14%. The average activity concentrations for the radioactive elements 238U (58-15 Bq/kg), 232Th (45-21 Bq/kg), 137Cs (46.47-18.68 Bq/kg), and 40K (9.5-4.82) Bq/kg. As a result of the rhizosphere's compatibility One of the main drawbacks of rhizoremediation is that it only functions when plant roots are visible due to microbial activities connected to the breakdown of hydrocarbons. Rhizoremediation thus fails when contamination is deeper than the root zone or at levels that are too high for roots to survive, as well as in compacted or highly clayey soils. The correct plant genotype must be selected in order to properly accomplish rhizoremediation since even closely related genotypes of the same plant may vary in their root development patterns and exudate amount and quality.[15].

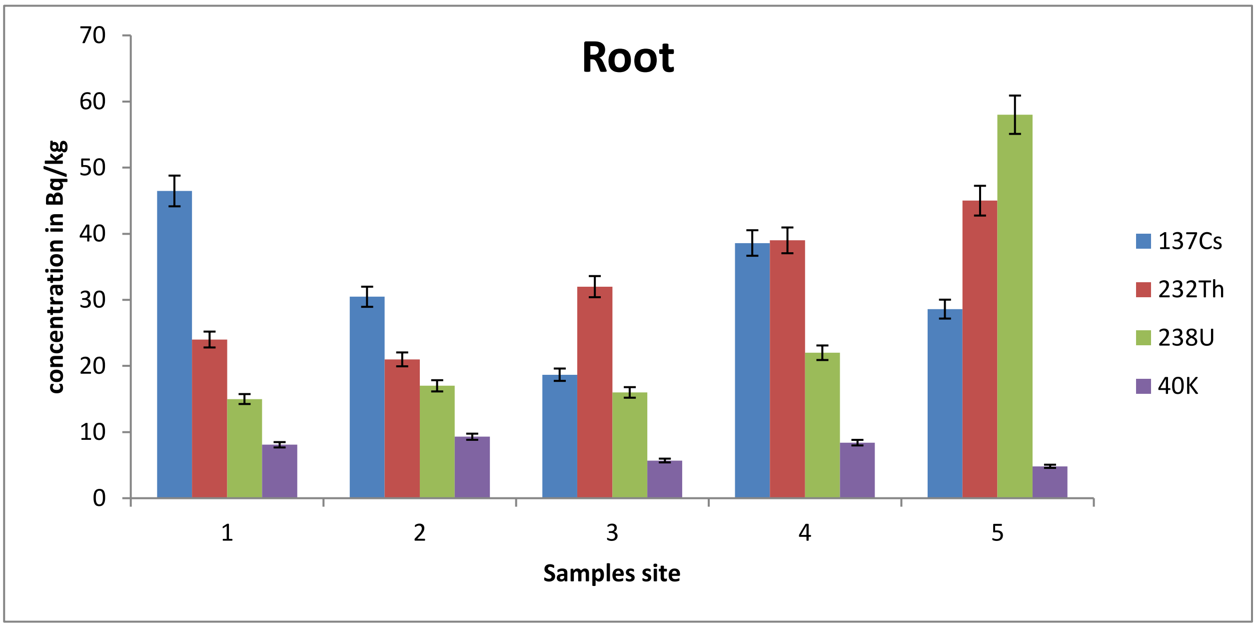

Figure (2) shows the specific activity owing to ^{238}U, ^{232}Th, ^{137}Cs and ^{40}K in roots sampled from all of the AL-Dora Refinery

The results of the measurements of the natural radionuclide content in the five areas under study are shown in Figure 3. Sites one and four had the highest levels of pollution (23%), while sites three and five had lower levels (19% and 19%, respectively). Site 2's soil had the lowest levels of natural radionuclides (13% and 13%, respectively). In the research region, the biggest pollutant natural radionuclide was 137Cs (39%); 232Th (32%), 238U (23%), and 40K (6%) and is induced by meteorological circumstances, notably the wind regime. Southerly winds blow often all year round. One may anticipate a significant elimination of materials with air fluxes toward the north when taking the direction of the dominant wind into consideration. There is also a connection between how different radionuclides are dispersed throughout a region. The average activity concentrations for the radioactive elements 238U (28-21 Bq/kg), 232Th (45-26 Bq/kg), 137Cs (45.5-25.48 Bq/kg), and 40K (17.2-2.6 Bq/kg) are particularly visible in hydromorphic and semi-hydromorphic soils within accumulative landscapes. There are several limitations, such as a long development time and dependency on environmental factors and plant growth, but many of these limitations may be overcome with proper design and species choice. Another problem is phytoremediation's low effectiveness, which may be raised by using a variety of methods that are fully discussed in this article. The inclusion of modifications may enhance the working mechanism, increase nutrient and water absorption, and hasten plant growth. The absorptive surfaces of roots may also be improved by microbial communities, which will increase metal absorption and organic pollutant decomposition. Genetically engineered plants have a large potential for rhizoremediation because of their accelerated plant development and overexpression of the genes that regulate metal absorption and transport [18, 20].

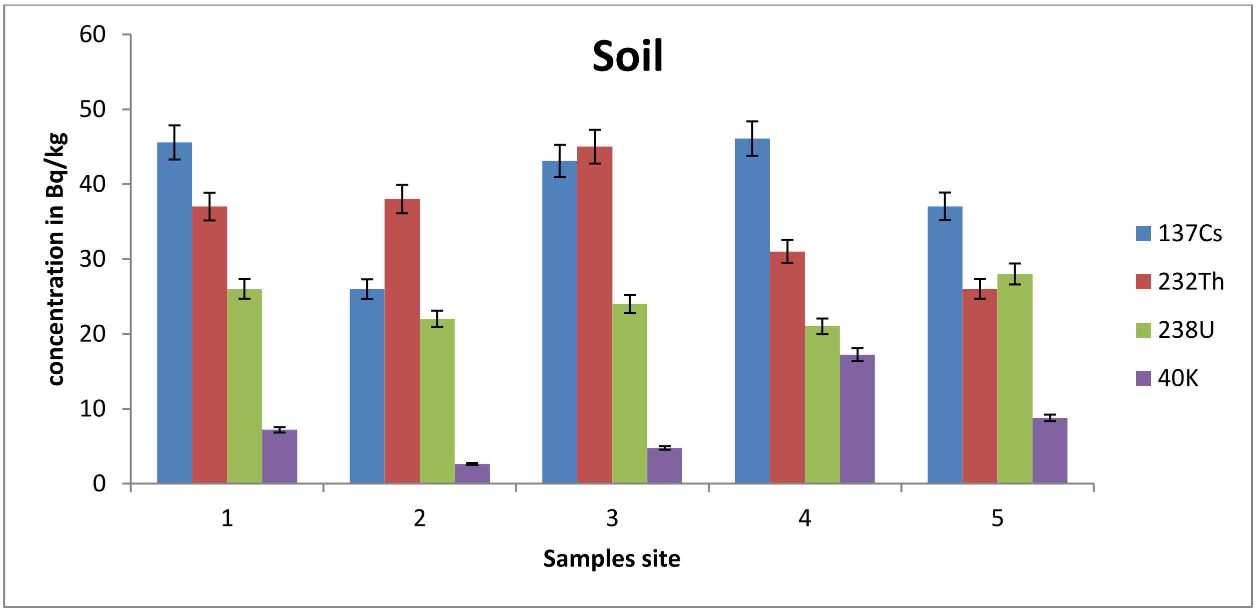

Figure (3) shows the specific activity owing to ^{238}U, ^{232}Th, ^{137}Cs and ^{40}K in soils sampled from all of the AL-Dora Refinery.

Calculation

As a result of the chemistry of naturally occurring radioelements in soils and streams, living creatures acquire radiological doses. Due to the quicker leaching of metals and minerals from rocks into the environment, mining activities enhance this dosage. The results discussed here provide information on the radionuclides that are present in soils from areas close to an AL-Dora Refinery, indicating the possibility that crops growing in soils affected by an AL-Dora Refinery could absorb radionuclides and then burn them, and highlighting the need for safety assessments in these areas.

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