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The effect of natural radionuclides on soil: Review

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Abstract

People are affected by nature radiation in several various forms depending on elements of the present radioactive nature in any location; such researchers investigating natural environmental radiation and radionuclides checks are being conducted by background on the soil to detect ambient radioactivity. Stages of radioactivity could use for evaluating the general average of portion, tainting of radiation and various anticipate in ecological radiation brought about by atomic mishaps agricultural activities, the transmission of radiation from soil to agriculture, crops, and other persons more active.

Keywords: Natural Radioactivity; Soil; Uranium; Thorium; Potassium.

1. Introduction

Radioactivity has long been a significant concern due to its relevance to human health. Radionuclides possess a range of biogeochemical reactions with significant mobilities, can damage the environment via bioaccumulation, and are detrimental to environmental and human well-being. Radioisotopes in the environment contribute to external radiation doses to humans, and isotopes taken up by ingestion and inhalation can be regarded as the sources of internal radiation doses. Investigations of radioactive material dose-effect relationships have advanced our understanding of radiation-related dangers and performed a significant role in developing radiological protection measures. Radionuclides are divided into natural radionuclides and artificial radionuclides. "NORM" describes the natural origin of radiation, derived from "naturally occurring radioisotopes", which include cosmic radioisotopes continuously produced by cosmic radiation effects and terrestrial radioisotopes. It can be attributed to the body. Terrestrial radionuclides include nucleated or primitive natural radioisotopes. It is classified as a natural decay sequence (^{235}U, ^{238}U and ^{232}Th), daughter nuclides with relatively long half-lives, and daughter elements of these daughter nuclides such as ^{226}Ra, ^{210}Pb, ^{210}Bi, ^{210}Po.On the other hand, the long-lived nuclei produce stable daughter elements in a single step. The most harmful radionuclide in this category is ^{40}K. The ^{40}K radioisotope releases high-energy gamma rays (1.46 MeV) [1-3]. Manufactured radionuclides have penetrated the environment around us due to nuclear weapons testing in the atmosphere. In addition to total deposition, the radiological relevance of a synthetic radioisotope can be determined through its radiotoxicity and radiation sort, bioavailability, and behavior throughout a food chain. Natural decay chain radionuclides are of considerable radiological relevance due to their short physical half-lives; they are continually generated and kept at consistent environmental levels. Some radioisotopes, such as iodine, are indistinguishable from their stable kinds and quickly enter biological systems. Others have close chemical similarities to minerals (Cs-K, Sr, Ra-Ca) that could contribute to considerable absorption into the food chain [4].

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	Source	Average topsoil (0–20 cm) content (Bq kg^{-1})	Soil inventory (kBq m^{-2})
^{14}C	Natural	330	
^{40}K	Natural	1–1000	
^{210}Pb	Natural	5–50	
^{226}Ra	Natural	5–200	
^{238}U	Natural	5–150	
^{234}U	Natural	9–120	
^{90}Sr	Bomb tests		Austria: range: 1–4
	Nuclear accident		ChNPP 30-km-zone: 18–1800
			Kyshtym region: 2000–4000
^{103}Ru	Nuclear accident		Austria: 3.7–74
^{137}Cs	Bomb tests		Austria: 23.4
	Nuclear accident		Denmark: 3.7
			ChNPP 30-km-zone: 1500–5000
$^{239/240}Pu$	Bomb tests		Austria: 1–15 × 10^{-2}
	Nuclear accident		ChNPP 30-km-zone: > 3.7

Figure 1 Some types of natural and artificial radionuclides present in the soil

Radiation affects humans from both natural and manufactured sources within our living environment. Knowing the natural radioactivity levels in all areas is very important for people to be aware of the natural radionuclides and detect fluctuations in radioactivity levels. Radioactive substances such as ^{40}K, ^{238}U, and ^{232}Th significantly contribute to surrounding radiation. ^{238}U and ^{232}Th concentrations within the soil are greater in concentrated places, while cosmic rays become more robust at higher altitudes. Radioactivity in the environment and the related external exposure to γ rays are highly reliant upon geological and geographical factors, and radioactivity appears to be found in varying amounts in soils throughout the earth. As a result, many scientists worldwide strive to quantify terrestrial doses of radiation from radionuclides in soil and examine radiation's impact on biological systems [5]. The most common types of ionizing radiation are alpha, beta, and gamma radiation. Radiation properties are significant in various fields, such as medicine, biology, industry, agriculture and power generation. Since radiation plays a vital role in various fields, Depending on their activity and environment, people may be impacted by radiation released from various sources [6]. Radiation might be one of the prerequisites for life and the growth of biological systems. However, it is generally known that ionizing radiation might harm human beings and biological processes. Natural radiation studies are critical since they are the main cause of human exposure. Naturally, radionuclide concentrations in soil samples can result in significant dose rates, as well as γ-irradiation through naturally occurring radioactive soil samples leads to whole-body dosages and, in some situations, β –irradiation can also lead to skin dosage. Because β-particles possess a larger specific ionization, they lose energy in the skin and cannot pass farther into the body. The first is the toxicity of U and Ra, and the second is the adverse impact Rn222 on the lungs. The content of radionuclides in soil samples varies from region to region, and natural radioactivity is commonly present in our soils and rocks. Harmful levels of radon and radon daughter substances, resulting from the decay of U238 and Th232, can accumulate in soil and pose a risk of lung cancer [7].

2. The effect of radionuclides in soil on human

Estimating natural radioactivity in soils and rocks is essential for measuring the degree of variation in natural radiation background as time passes caused by radioactive substance release. Environmental protection depends on the monitoring of radioactive emissions into the environment. Natural radioactivity research is required for its radiological impacts and as an effective biochemical and geochemical tracer in the environment. [8]. Two primary radiological impacts caused by soil radionuclides merit determining attention. The first is internal irradiation of the lungs by the α-emitting progeny (^{222}Rn and ^{220}Rn), which have a short half-life. The second involves externally exposing the body to gamma rays produced in place by radionuclides. The selection of sampling survey methods is crucial in constructing radiological characterization methods to establish soil measurements across broad areas. The characteristics of the radiation field and the approximative radionuclide concentrations are determined by in-situ gamma-ray measurements, which enables quick localization of regions with the highest radioactivity concentrations. This approach, however, is quite expensive and often necessitates an aerial measurement system with modern measuring instruments. Contrarily, laboratory testing of radionuclides of field samples not only satisfies the goals of in situ measurement at minimal cost but also allows for creating radon maps that include potential high indoor radon concentrations [9]. Radioactivity in the air or on farmland and soil can be transferred to the crops grown there. However, a certain amount of certain radioactive elements gets into the human body. Swallowing food, water, or other items that enter the mouth. This is typically the result of poor housekeeping, poor personal cleanliness, or consuming food in radioactive zones. The gastrointestinal tract absorbs and excretes ingested material, and solubility influences absorption and excretion. The water-soluble substances enter the bloodstream and can easily be transferred to the body's organs. The insoluble material passes through the intestines and is excreted. Roots absorb nutrients mainly from the soil solution. Transmission to plants occurs through radioactivity uptake by the root system or the outer surfaces of the plant. Root uptake continuously consumes dissolved substances in the soil solution. However, it is also regenerated from the solid state of the soil. Estimating the uptake of radionuclides from the soil is difficult due to the complicated structure of soil plants' temporal and geographical relationships. People are advised to eat a large number of grains every day as these grains are rich in minerals, fiber and protein. They contain vital and toxic metals and radionuclides that have been shown to benefit people's overall health. Containing proteins, pectins, lipids, salt and minerals, wheat is also rich in nutrients, fiber and carbohydrates [10]. Excessive radiation can have somatic (affecting the body) and genetic (affecting future generations) effects. The somatic effects include the development of tumors and various forms of tissue damage. The genetic effects result from damage to germline stem cells (sperm and egg cells), which are then passed on to future generations. When controlling radiological risks, knowing the speed at which the radiation is received is necessary. Therefore, estimates of the measured levels of radionuclides were made to calculate the absorbed gamma radiation dose rate and the equivalent radium (Req) External hazard index (Hex) resulting from natural radionuclides in the soil. Estimates of the total radiation dose exposed to the world's population found that about 96% came from natural sources and 4% from artificial sources[11]. Although these radioactive substances are extensively dispersed, their concentrations fluctuate from location to location due to local geological circumstances. Many government and international organizations, like the Worldwide Commission on Radiological Protection (ICRP) and the World Health Organization (WHO), have created guidelines to reduce the health risks connected to indoor radiation exposure. We are taking drastic steps [12].In general, investigating the distribution of natural radionuclides in soil monitors radioactivity in places where people live, which is critical for human health. This is one of the most often-used approaches for calculating population risk. Analyzing their presence in soil is crucial because of the biological interactions between natural radionuclides and plants [13]. The soil-plant-human path represents one of the leading environmental routes by which humans absorb radionuclides. Many factors influence radioactive uptake by plants, including soil qualities, plant varieties, physiological processes within every plot, competing ions, climate circumstances, radionuclide physicochemical forms, and agricultural techniques [14].

3. Conclusion

Soil is considered an essential and necessary primary resource for life and food production. The existence of natural radioactivity in soil results in inside and outside exposure to humans. Natural radioactive materials stand for the largest donating of radiation doses received by human beings, where the natural radioactivity is found in almost all soil types although the concentrations vary greatly. Therefore, the study of radionuclides in soil samples becomes very important due to their radiological hazards to humans.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declared that there is no conflict of interest.

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