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Transfer Factors of Radionuclides in the Herbal Gardens in Myanmar

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Abstract

The activity concentration of radionuclides in soil and plant was measured in this research with the aim of determining the transfer factors of radionuclides from soil to plant collected from Herbal gardens in Myanmar. Plant and corresponding soil samples were collected from three different gardens of Sae Pauk herbal garden at Kyauk Pa Daung Township and National herbal garden (Nay Pyi Taw) at Pyin Ma Na Township, Hpaung Taw herbal garden at Pyin Oo Lwin Township. The activity concentrations of natural radionuclides ^{238}U series, ^{232}Th series and ^{40}K were measured using gamma ray spectrometry. Soils of Hpaung Taw herbal garden contained more ^{238}U series than Sae Pauk herbal garden and National herbal garden, whereas soils of Sae Pauk herbal garden contained more ^{232}Th series than National herbal garden and Hpaung Taw herbal garden. Soils of National herbal garden contained more ^{40}K than Sae Pauk herbal garden and Hpaung Taw herbal garden. The soil to plant transfer factors for ^{40}K was found to be much higher in plants, which might be due to the essentiality of element in plants.

Keywords: Soil–to –plant transfer factor, activity concentration, tropical environment

Introduction

There are many sources of radiation and radioactivity in the environment. Radioactive elements can be found in nature, and they can be placed in three general categories: Primordial- formed before the creation of the Earth, Cosmogenic- formed as a result of cosmic ray interactions, and Human Produced – formed due to human actions. Radioactivity is a part of everyday life. Depending on the typology of the source, it is possible to divide in natural and artificial radioactivity. Natural radioactivity is common in the rocks and soil that makes up our planet, in water and oceans, and in our building materials and homes. The natural sources of radiation in environment are responsible for some background radiation. The major sources of external gamma radiation are K-40, uranium-238, thorium-232 and their decays products originated in each area in the radioactive elements of thorium (Th), uranium (U) and potassium (K). Natural sources are cosmic rays and the radioactive content of soil and rocks. Artificial radioactivity derives from man activity and is generated in different applications, ranging from nuclear installations, nuclear accident or normal radionuclides.

Experimental Details

1. Study Area and sample collection

The soil and plant samples were collected from Hpaung Taw herbal garden at Pyin Oo Lwin Township, Sae Pauk herbal garden at Kyauk Pa Daung Township and National herbal garden (Nay Pyi Taw) at Pyin Ma Na Township, Mandalay division. For present measurement, soil samples were also collected with plant samples such as Alpinia officnarum (Padegaw), Andrographis paniculata (Say gha gyi), Adhatoda vasica Nees (Mayar gyi). One kilogram of soil samples were also collected 0-5, 5-10, 10-15 and 15-20 cm depths. To remove extraneous materials such as roots, mat portions, pieces of stone and gravel, soils were well cleaned. Plant sample 500 g was cleared by fresh water for removing the dust and mud and then plant sample was ground to get fine powder. All samples were dried at shelter, avoiding the loss of any volatile radionuclide. The dried samples were pulverized and sieved to pass through a 1-2 mm mesh. The mashed soil and plant samples were transferred to plastic cylindrical container.

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2. Experimental Set-Up for Gamma Emission Measurement

The experiments were carried out using gamma ray spectroscopy system with high purity germanium detector (HPGe). In gamma ray spectroscopy system, the follow equipments were included. They were the HPGe detector ORTEC (model GMX 10P4-70-RB-SMN),cooler (model CFG-X-COOL-III-230), preamplifier (model A257N), fast spectroscopy amplifier ORTEC (Model-671), high voltage power supply, photomultiplier tube, digital signal processor (DSPEC-LF), a pulse stored multi-channel analyzer (MCA) together with Gamma Vision-32 software installed in PC, high voltage power supply and data readout devices. The operation voltage for HPGe detector is negative 1500 V dc. The detector was surrounded with a lead shielding to reduce a possible background radiation that comes from the environment; lead (Pb) shielding was used in this measurement [2]. Using the displayed energy information, an unknown radioisotope can be identified radionuclide with activity concentration and a picture of the spectrum and then determined by gross and net area of full energy peak. To reduce a possible background radiation that comes from the environment, lead (Pb) shielding (thickness is 7 cm) was used in this measurement. For present measurement, the samples were placed in container and measured for about 3 hours. The background spectrum was measured with the same conditions. At the end of the counting period, the spectrum that was recorded may be displayed on the screen. The spectra stored in MCA were analyzed by the application of Gamma Vision-32 software. Using the displayed energy information, an unknown radioisotope can be identified radionuclide with activity concentration and a picture of the spectrum and then determined by gross and net area of full energy peak.

3. Calculation of Transfer Factor (TF)

Radionuclides uptake by plants from contaminated soil represents a key step of radionuclides input into human food chain; this phenomenon is described by soil to plant transfer factor that is defined as the ratio between plant specific activity and soil specific activity. The transfer factor (TF) is a value used in evaluation studies on impact of routine or accidental releases of radionuclide into the environment. The soil to plant transfer factor is regarded as one of the most important parameter in environmental safety assessment needed for nuclear facilities. This parameter is necessary for environmental transfer models which are useful in prediction of the radionuclide concentrations. The soil-to-plant TF measured the transfer of radionuclide from soil to plant taken through the plant roots. The TF values were calculated according to the equation [1]:

$$\mathrm{TF} = \frac{\text{Activity of radionuclides in plant } (\mathrm{Bqkg^{-1}})}{\text{Activity of radionuclides in soil } (\mathrm{Bqkg^{-1}})}$$

Results and discussion

The activity concentrations of ^{238}U for soils of Sae Pauk herbal garden at Kyauk Pa Daung Township was found with an average value of 30.73 Bq/kg, National herbal garden (Nay Pyi Taw) at Pyin Ma Na Township was found with an average value of 29.95 Bq/kg and Hpaung Taw herbal garden at Pyin Oo Lwin Township was found with an average value of 38.76 Bq/kg. The highest activity was found in Hpaung Taw herbal garden at Pyin Oo Lwin Township. The activity concentrations value for ^{232}Th of soils of Sae Pauk herbal garden at Kyauk Pa Daung Township was found with an average value of 37.35 Bq/kg, National herbal garden (Nay Pyi Taw) at Pyin Ma Na Township was found with an average value of 36.13 Bq/kg and Hpaung Taw herbal garden at Pyin Oo Lwin Township was found with an average value of 34.51 Bq/kg.. The highest activity was found in Sae Pauk herbal garden at Kyauk Pa

Daung Township. The activity concentration of ^{40}K in soils from Sae Pauk herbal garden at Kyauk Pa Daung Township was found with an average value of 525.66 Bq/kg, National herbal garden (Nay Pyi Taw) at Pyin Ma Na Township was found with an average value of 580.87 Bq/kg and Hpaung Taw herbal garden at Pyin Oo Lwin Township was found with an average value of 430.26 Bq/kg. The highest activity was found in National herbal garden. The radioactivity of ^{238}U, ^{232}Th and ^{40}K was also measured in plants corresponding to the soils collected from Sae Pauk, Nay Pyi Taw and Hpaung Taw herbal gardens.

Plant Type	Location	Transfer factor		
		^{238}U	^{232}Th	^{40}K
Alpinia officnarum (Padegaw)	Sae Pauk herbal garden	0.14	0.33	0.67
	National herbal garden	0.11	0.28	0.64
	Hpaung Taw herbal garden	0.10	0.24	0.62
Andrographis paniculata (Say gha gyi)	Sae Pauk herbal garden	0.27	0.16	0.69
	National herbal garden	0.21	0.12	0.68
	Hpaung Taw herbal garden	0.26	0.18	0.65
Adhatoda vasica Nees (Mayar gyi)	Sae Pauk herbal garden	0.14	0.23	0.73
	National herbal garden	0.17	0.25	0.79
	Hpaung Taw herbal garden	0.18	0.29	0.77

Results predicted that for all transformation from soil to plant, potassium has highest average TF. This was due to the fact that potassium is an important element to plant fertility, even though potassium is a radioactive element, but it does not harm the environmental system. This variation observed in TFs for the plant samples is due to various factors such as age of the plant, and the environment in which the plant is grown. This indicated that, some plant species concentrate higher ^{40}K radionuclides than others, and plants may uptake potassium from soil as an essential element of metabolism and other radionuclides may be taken as a homologue of an essential element. This higher activity of ^{40}K might be attributed to the higher biological requirement of plants for potassium as it is a major essential nutrient element. The higher transfer factor of potassium at that time was not at risk streak because that value was not at staid position to harm the body. As a higher concentration of radioactive substances in the environment is undesirable, investigations should be undertaken to detect the concentration of radionuclides in soil and their transfer to plants in order to take necessary radiological and dosimetric measures with the aim of minimizing the harmful effects of ionizing radiation.

Conclusions

It has also been noticed that the transfer factor is higher in Sae Pauk herbal garden at Kyauk Pa Daung Township if compared to the other study gardens seems to have a totally different behavior. This might be attributable to the peculiar nature of the soil texture and composition. The high activity concentration of potassium recorded in Andrographis paniculata (Say gha gyi) plant and Adhatoda vasica Nees (Mayar gyi) plant. It can be concluded that the transfer factor is slightly different for the same plant with different gardens. Similarly, at the same garden with different plants the transfer factor is not the same.

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