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Environmental ^{238}U and ^{232}Th concentration measurements in an area of high level natural background radiation at Palong, Johor, Malaysia

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Abstract

Concentrations of uranium-238 and thorium-232 in soil, water, grass, moss and oil-palm fruit samples collected from an area of high background radiation were determined using neutron activation analysis (NAA). U-238 concentration in soil ranged from 4.9 mg kg^{-1} (58.8 Bq kg^{-1}) to 40.4 mg kg^{-1} (484.8 Bq kg^{-1}), Th-232 concentration ranged from 14.9 mg kg^{-1} (59.6 Bq kg^{-1}) to 301.0 mg kg^{-1} (1204 Bq kg^{-1}). The concentration of U-238 in grass samples ranged from below the detection limit to 0.076 mg kg^{-1} (912 mBq kg^{-1}), and Th-232 ranged from 0.008 mg kg^{-1} (32 mBq kg^{-1}) to 0.343 mg kg^{-1} (1.372 Bq kg^{-1}). U-238 content in water samples ranged from 0.33 mg kg^{-1} (4.0 Bq L^{-1}) to 1.40 mg kg^{-1} (16.8 Bq L^{-1}), and Th-232 ranged from 0.19 mg kg^{-1} (0.76 Bq L^{-1}) to 0.66 mg kg^{-1} (2.64 Bq L^{-1}). It can be said that the concentrations of environmental U-238 and Th-232 in grass and water samples in the study area are insignificant. Mosses were found to be

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possible bio-radiological indicators due to their high absorption of the heavy radioelements from the environment.

Keywords: Environmental; Soil; Uranium-238; Thorium-232; Radiation; Activity concentration

1. Introduction

The most common terrestrial radioelements that produce gamma-rays are uranium-238, thorium-232 and potassium-40. The study of natural terrestrial radiation is useful for various reasons as have been reported by many authors including Eisenbud (1964), Frenzel (1993), Erickson et al. (1993), Ramli (1997) and Maiello (1997). Around the world there are some areas having extremely high background radiation levels. High external radiation levels have been found in Austria, Brazil, China, France, India, Italy and other countries as pointed by Hanson and Kamarov in 1983 (Malanca et al., 1993). Highest concentrations of radioactive minerals in soil are found in Brazil and India (Radhakrishna et al., 1993).

Most of the radioactivity in the terrestrial environment whether it is natural or man-made, is bound to the components of the soil. Transportation of this radioactivity from soil is possible to vegetation via dust deposition or root uptake, water sources by flood wash-down, and forward to humans through inhalation, breathing and soil ingestion. Therefore, all pathways of exposure that originate from soil are potentially important for the purpose of radiation risk assessment. Considerable attention has been given to the soil radioactivity, mainly for the purposes of establishing baseline data for future radiation impact assessment, radiation protection and exploration.

Radhakrishna et al. (1993) studied natural background radiation in the southwest coast of India. Systematic gamma spectrometric analysis indicated that the presence of monazite is the cause of the observed high natural background radiation in the area. In the same area, Narayana et al. (1995) studied the distribution and enrichment of radionuclides, and have observed that the monazite deposit in the area is predominant in the upper (0–10 cm) layer. The source of the monazite may be traced to the rocks in the area that were weathered and the released minerals were transported by the river and deposited on the coastal areas. Ibrahim et al. (1993) measured the radioactivity levels in the soils of the Nile Delta and middle Egypt. It was shown that the highest radionuclide activity occurs in clay soils and the lowest occurs in sandy soils. The highest Cs-137 activity was found in the region of the dark clay and muddy clay soils.

Various studies concerning radioactivity bound to soil were carried out in European countries. For example, Quindos et al. (1994) studied on the natural radioactivity in Spanish soils. Concentrations of Ra-226, Th-232, and K-40 were obtained and the radionuclides were correlated to the external exposure rates from terrestrial gamma radiation measured throughout Spain. Bonazzola et al. (1993)