Analyzing low levels of naturally occurring radionuclides in foods – Insights from the first German total diet study

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The presence of natural radionuclides in foods is well-known, yet detailed information on their levels remains limited. The presented investigation seeks to bridge this gap by systematically examining the diet-related activity concentrations of naturally occurring radionuclides, including lead-210 (Pb-210), uranium-234 (U-234), uranium-238 (U-238), radium-226 (Ra-226), and radium-228 (Ra-228). Conducted by the Federal Office for Radiation Protection (BfS) in collaboration with the Federal Institute for Risk Assessment (BfR), over 200 different foods were sampled and analyzed from 2016 to 2019 (Hofmann et al., 2024) as part of the first German total diet study (BfR MEAL Study) (Sarvan et al., 2017).

Homogenized and pooled samples, averaging 2 kg in fresh weight, were delivered from the BfR to the BfS. The samples underwent drying at 105 °C and dry-ashing at 400 °C, resulting in ash yields between 5 g and 119 g. Before starting with the radiochemical separation techniques, between 2 g to 10 g ash material were dissolved by microwave digestion for each radionuclide analysis. Pb-210 was quantified via co-precipitation with iron hydroxide, followed by extraction chromatography, and liquid scintillation counting, achieving an average chemical yield of 74% and a detection limit of 16 mBq/kg fresh weight. U-234 and U-238 were determined through sequential extraction and alpha spectrometry, offering a robust detection limit of 0.91 mBq/kg fresh weight, albeit with a slightly lower yield of 63%. Ra-228 and Ra-226 determinations were combined for efficiency, using progeny Ac-228 for Ra-228 measurement and the Rn-222-emanation technique for Ra-226. The detection limits were 20 mBq/kg for Ra-228 and 5 mBq/kg for Ra-226, with a chemical yield of 90%.

The study revealed generally low radionuclide activity concentrations compared to international data, though Ra-228 and Ra-226 frequently dominated the activity levels (Hofmann et al., 2025). Between 1% and 19% of Ra-226, Ra-228, and Pb-210 results exceeded the International Atomic Energy Agency (IAEA) guidance levels of 0.1 Bq/kg or 1 Bq/kg, while U-234 and U-238 remained below the IAEA's suggested threshold of 10 Bq/kg. Intriguingly, the average Ra-226/Ra-228 ratio in food items was significantly lower than that found in soils, indicating an isotope-dependent transfer of these radionuclides from soil to plants and subsequently to the food chain. These results provide a foundational basis for further dose assessments and risk evaluations, thus enhances our understanding of public exposure to natural radionuclides through food consumption.

References

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