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Effect of wet and dry processes on the gastrointestinal absorption of radiocesium adsorbed to soil particles in rats

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Radiocesium is a major radionuclide discharged into the environment as a result of the Fukushima Daiichi Nuclear Power Plant accident. Because radiocesium isotopes have relatively long physical half-lives (134Cs: 2.065 years; 137Cs: 30.04 years), they are the most significant long-term radioactive contaminants in the environment. When radiocesium is deposited on solid ground, it remains in the soil surface layer for a long time owing to its strong adsorption on soil particles. Soil aging enhances the adsorption of radiocesium on soil particles and limits its phytoavailability [1]. In this study, the effects of soil aging on bioavailability were investigated by estimating the absorption of radiocesium adsorbed on soil particles in rats after wet and dry soil weathering processes.
Soil samples were dried at 45 ℃, grinded in a mortar, and passed through a 250-μm mesh. 134CsCl was added to the soil samples and dried at 40 ℃. Subsequently, wet and dry weathering processes (watering and drying at 40 ℃) were repeated up to 20 times, and each soil sample was encapsulated. Soil samples were administered to five female Wistar rats aged 8—10 weeks in capsules by intragastric cannulation. After administration, the whole-body activity of 134Cs was measured over time by a whole-body counter. 134Cs absorption was estimated using the least-squares method with a biphasic curve with fast and slow compartments.
After adding 134Cs to the first soil sample, the absorption rate of 134Cs in rats was 24 ± 6.8%. After 10 and 20 repetitions of wet and dry processes, the absorption rates decreased to 12 ± 3.1%and 1.0 ± 0.9%, respectively. These absorption rates are significantly lower than that of ionic forms such as CsCl [2], and the International Commission on Radiological Protection's recommended absorption value (absorption rate = 1.0) [3]. It was also found that wet and dry processes made the adsorption of 134Cs on soil particles stronger and limited the isotope's bioavailability. Therefore, it can be inferred that when humans or animals ingest soil particles contaminated with radiocesium, the amount of time between deposition and ingestion influences the absorption rate and internal exposure dose.

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[1] Akira Takeda, et al. Time-dependent changes of phytoavailability of Cs added to allophanic andosols in laboratory cultivations and extraction tests. J. Environ. Radioact., 122, 29-36. (2013)
[2] Simeon Pollack, et al. The absorption of nonferrous metals in iron deficiency. J. Clin. Investig. 44, No.9. 1470-1473. (1965)
[3] ICRP79 International Commission on Radiological Protection 1979, "Limits for Intake of Radionuclides by Workers, Part 1,"ICRP Publication 30.

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