§25. LHD Project and Estimation of Biological Effects of Tritium

Ichimasa, Y., Ichimasa, M. (Ibaraki Univ.),
Momoshima, N. (Kumamoto Univ.),
Amano, H., Ando, M. (JAERI),
Okai, T. (Kyushu Univ.),
Komatsu, K. (Kyoto Univ.),
Takeda, H., Miyamoto, K. (NIRS),
Tauchi, H. (Ibaraki Univ.),
Takahashi, T. (Kyoto Univ.),
Sakuma, Y., Uda, T.

As for tritium taken into human body via food chain, the dose due to organically bound tritium (OBT) is 2-3 times higher than that due to tritiated water (HTO). Studies on OBT formation and translocation to the edible part of main crops in the local environment are limited and required for dose assessment purpose before the opening of mass usage of tritium in nuclear fusion plants. We have conducted several times of heavy water (D_2O) vapor release experiments in a greenhouse in the Mito campus of Ibaraki University using deuterium as a substitute for tritium, and uptake and loss kinetics of D_2O in leaves of orange, persimmon, sweet potato and rice plants etc. and formation, translocation and retention of organically bound deuterium (OBD) were investigated during and after the D_2O exposure for 8 hrs in daytime and nighttime in August, respectively. These parameters were rather different among plants specie such that rate constant of D_2O uptake in leaves of sweet potato and orange in the daytime release were about 10 times higher than those in the nighttime release while in the case of persimmon leaves, rate constant in daytime release was about twice that in nighttime release.

Using developed analytical methods of tritium segregated into three types of chemical forms, tritiated water, tritium gas and tritiated methane, the changes of tritium concentration of each chemical form in the atmosphere were investigated in Toki site and compared with those in Fukuoka. The present concentrations of HTO in both areas were almost the same and decreased to the low tritium level observed before the beginning of nuclear tests, while present tritium gas concentrations were about 120 times higher than the days before testing. These results suggest the presence of some source and need for further studies.

In previous paper, mice were chronically fed with each one of tritiated organic compounds, T-thymidene, T-leucine, T-glucose, or HTO for comparison. Almost no significant differences were found between the dose rates from DNA-bound tritium throughout long-term exposure by ingestion of tritiated organic compounds and that of HTO. The biological effect of very low level of tritium intaken in body was investigated using comet assay method for detection of DNA damage in a cell nucleus. Two lines of male mice were administered HTO, 4-20 kBq/g body weight, and collected lymphocytes at 1 and 10 days after the administration to measure DNA damage. No significant damage on DNA was detected.

In order to observe if the reversed dose rate mutation effect could be seen with low dose rate tritium radiation, a novel hyper-sensitive detection system was developed to detect Hprt-deficient mutations using Hprt-deficient hamster fibroblast cells which carry a normal human X-chromosome, which has been found to be 100-fold more sensitive for detecting mutation than the conventional system. (Hprt is an abbreviation of the enzyme named hypoxanthine-guanine phosphoribosyl-transferase. The enzyme acts for reuse of nucleotide in nucleic acid synthesis. Because Hprt is not essential, loss of the enzyme activity is often used as a marker of somatic mutation detection.) The mutation frequency induced 1 Gy of tritium radiation at different dose rates (0.9, 0.4, 0.04 and 0.018 Gy/h) was measured. No significant differences were observed within the range of dose rates used, suggesting that if a reverse dose-rate effect exists, it may not be observable with tritium radiation at dose rates over 0.018 Gy/h. Molecular analysis of the Hprt locus in Hprt-deficient mutants induced by tritium showed that the deletion size observed in the hamster cell's human X-chromosome were much smaller in cells exposed at 0.04 and 0.018 Gy/h than in cells exposed at 0.9 Gy/h. This phenomenon seems to be specific for tritium radiation because it was not apparent after exposure to γ - rays. These results indicate the usefulness of this novel mutation detection system for risk assessment of low dose rate tritium exposure.