Accumulation of organically bound tritium in Komatsuna grown in tritium water dripping soil

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A large amount of tritiated water will be generated in a Deuterium – Tritium fusion reactor because tritium can permeate through metal cooling tubes into the cooling water at high temperature conditions. Considering the safety of public and environment, the most important technical issue for the fusion reactor is confinement of the tritium within the fusion power generation site. On the other hand, from a viewpoint of social acceptance of the fusion reactor, it is also important to clarify tritium behavior in the environment assuming a severe accident including the release of tritiated water to the environment. When some amounts of tritiated water is released to the surrounding soil, there would be a possibility that tritium is absorbed into the plants and stay in the plants for a long time. Most of the tritium absorbed in the plants exists in a form referred to as tissue free water tritium (TFWT), which is not bounded to tissues. Some tritium exist as organically bound tritium (OBT), which is bounded to plant tissues through photosynthesis [1]. OBT is further classified into exchangeable OBT (eOBT) and non-exchangeable OBT (neOBT). neOBT is strongly bounded to carbon in plants until the organic substance is decomposed. On the other hand, eOBT is bound to sulfur, nitrogen, and oxygen atoms [2]. Since the behaviors of eOBT and neOBT are significantly different, it is important to evaluate the amount of tritium uptake into plants with discrimination between eOBT and neOBT. In this study, an airtight space was constructed in which plants were cultivated without tritium release to the surrounding, and an edible plant, Komatsuna was cultivated in the soil which had tritiated water. After that, leaves and stems were collected, and the amount of tritium uptake was measured using liquid scintillation.

Figure 1 shows the illustration of the cultivation equipment. Two airtight glove boxes were installed in the upper and the lower part of an incubator respectively. Six (6) samples of Komatsuna with all its leaves removed was placed in each box. 6 cc of tritiated water at a concentration of 150 kBq / cc was dropped to the culture soil of each sample in the upper box. Fresh air was continuously supplied by one pump and the air in the inside space containing tritium was evacuated by another pump. The tritium in the exhaust air was collected with water bubblers. The samples were always exposed to illumination. Leaves and stems were collected from Komatsuna cultivated for several days as samples for measuring the tritium uptake. To measure the amount of TFWT, water immersion and vacuum drying were performed. Next, to recover the eOBT by isotope exchange reaction with water vapor, the sample was exposed to moist air at room temperature. Finally, to measure the amount of neOBT, the sample was combusted at 800 ℃ in a glasswool fixed quartz tube. It was obtained that TFWT was 6.35 kBq/g, eOBT was 1.91 kBq/g, and neOBT was 0.77 kBq/g. The fraction of neOBT to total tritium uptake was found to be 8.55%. It was indicated that about 10 % of the tritium transferred from the soil into the stems of Komatsuna is stably accumulated as neOBT.

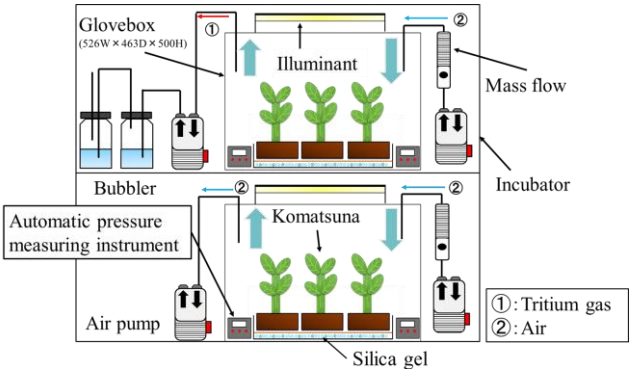

Figure 1 - Experimental equipment for cultivation.

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[2] S. Diabat´e, et al, Organically bound tritium, Health Phys. 65 (1993) 698–712.