Concentration Coefficients of Radioiodine in Different Chemical Forms from Seawater to Fishery Products

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Abstract

Radioiodine takes various chemical forms in the environment. Ion forms of both I^- and IO_3^- were found in the ocean for ^{129}I discharged from the first Japanese commercial nuclear fuel reprocessing plant located in Rokkasho. Since the concentration factor of iodine from seawater to marine products strongly depends on the chemical form of iodine, it is necessary for realistic assessment of radiation dose from the discharged radioiodine via marine products to use the concentration factor of each chemical form of iodine. This study aims to establish the concentration factor of radioiodine in I^- and IO_3^- for marine products (seaweed, shellfish and benthos). In FY 2015, 1) the concentration factors of I^- and IO_3^- for sea cucumber (*Apostichopus japonicus*) were measured using an iodine radiotracer and 2) the chemical form of stable iodine in sea cucumber was analyzed by using X-ray absorption fine structure (XAFS) analysis.

We exposed sea cucumber samples obtained from local fishermen to $^{125}I^-$ or $^{125}IO_3^-$ in seawater using air-tight chambers, followed by collecting the samples at pre-determined time until 72 h after the start of exposure. No feed was administered during the exposure. Three samples were collected at each time, followed by drying in vacuo after removing seawater in their body cavity. The dried samples were measured for ^{125}I concentration by using a NaI auto-counter. The seawater in the chamber was also collected at the time of sea cucumber sampling, and $^{125}I^-$ and $^{125}IO_3^-$ in it were separately measured by their radiochemical separation using an anion exchange column. The exposure experiment was repeated twice excluding exposure time of 48 h in the second experiment, and each results are separately presented in Fig. 1 and 2. As shown in the figures, the intake rate of sea cucumbers in the first experiment was obviously higher than that in the second one. The $^{125}I^-$ concentration in seawater in the first experiment also rapidly decreased in comparison to that in the second one. The $^{125}IO_3^-$ concentration in seawater did not significantly decreased in both experiments.

A single compartment metabolic model of iodine in sea cucumber with separate inputs of $^{125}I^-$ and $^{125}IO_3^-$ was constructed (Fig. 3), and transfer-rate coefficients in it were estimated by fitting the experimental data (Table 1). The transfer-rate coefficients of input for $^{125}I^-$ (k_1) and $^{125}IO_3^-$ (k_2) and of output (k_3) in the first experiment were estimated as 6.E1, 6. and 1.E-1, respectively. The values of k_1, k_2 and k_3 in the second experiment were obtained as 5., 1. and 3E-2, respectively, showing that metabolism of ^{125}I was less active in the second experiment than in the first one by unknown reasons. Concentration factors of $^{125}I^-$ and $^{125}IO_3^-$ in the first experiment was 6.E2 and 6E1, respectively, while they were 2.E2 and 5.E1, respectively, in the second one. Both results showed that the concentration factor of $^{125}I^-$ for sea cucumber was larger than that of $^{125}IO_3^-$. It should be noted that ingestion intake of iodine into sea cucumber was not considered here.

The chemical forms of stable iodine in sea cucumber tissue samples was analyzed by XAFS. Although no clear spectrum was obtained because of low iodine concentration in the samples, it suggested that most of the iodine in sea cucumber tissue was in organic form.

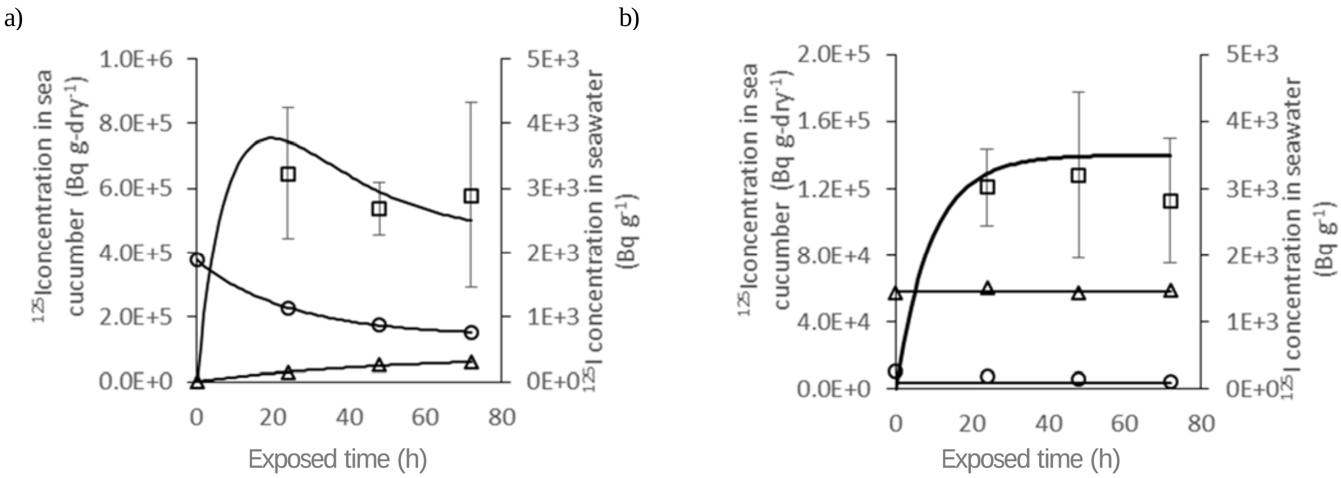

Fig. 1 Measured ^{125}I concentration in sea cucumber and seawater during the first experiment. Open square shows ^{125}I concentration in sea cucumber (Bq g-dry^{-1}). Open circles and triangles show $^{125}I^-$ and $^{125}IO_3^-$ concentrations in seawater (Bq g^{-1}). Solid lines show estimated value by the model.

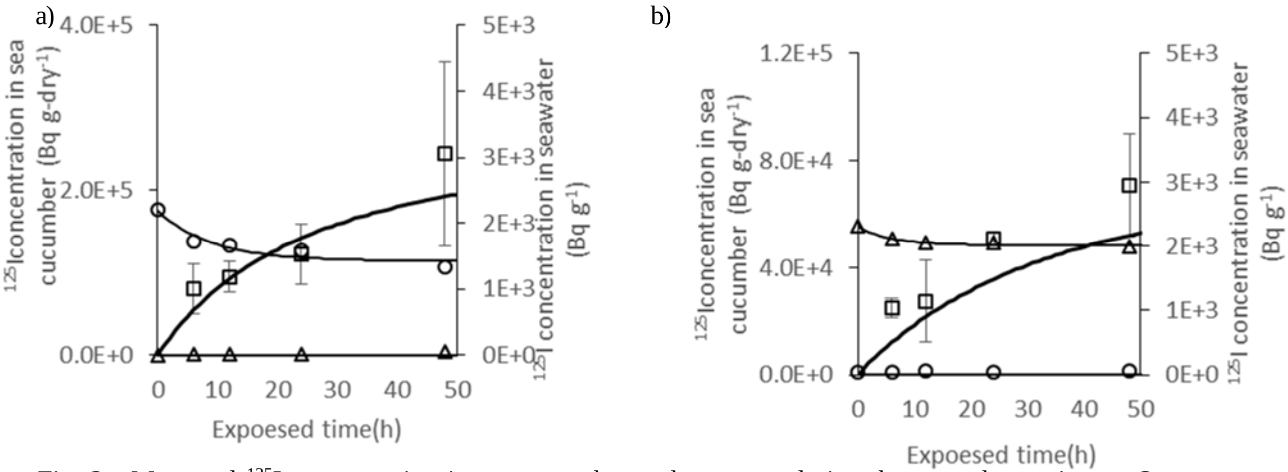

Fig. 2 Measured ^{125}I concentration in sea cucumber and seawater during the second experiment. Open squares show ^{125}I concentration in sea cucumber (Bq g-dry^{-1}). Open circles and triangle shows $^{125}I^-$ and $^{125}IO_3^-$ concentrations in seawater (Bq g^{-1}). Solid lines show estimated value by the model.

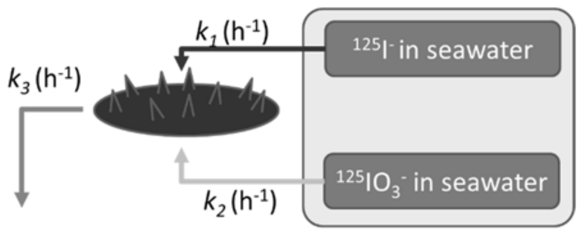

Fig. 3 Metabolic model of ^{125}I in sea cucumber.

Table 1 Obtained transfer-rate coefficients.

	k_1(h^{-1})	k_2(h^{-1})	k_3(h^{-1})
1st experiment	6.E1	6.	1.E-1
2nd experiment	5.	1.	3.E-2