Study on the Transfer of Carbon from Grass to Beef and Milk

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Abstract

The radiation dose due to ^{14}C released from a spent nuclear fuel reprocessing plant is delivered to the neighboring population mainly through intake of agricultural and daily products. In the vicinity of the reprocessing plant in Rokkasho, Aomori, Japan, stock-farming is widely undertaken, including cattle-breeding. Then, it is important to clarify how fast ^{14}C is transferred and how much it accumulates in cattle. In this study, transfer coefficients of ^{14}C from grass to meat and milk of cows were experimentally examined using a stable isotope of carbon (^{13}C) as a substitute tracer for ^{14}C.

Changes in ^{13}C isotopic ratio were measured in breath air, urine, feces, milk, muscle and serum of beef cattle and milking cows which had been given ^{13}C-labeled grass feed for 28 days. Using the data obtained, the cattle and cow Carbon Metabolism Model was developed. The estimated ^{14}C concentrations in beef and milk of cows which are bred under typical conditions in Rokkasho Village were lower than the prediction by the conventional method i.e. the specific activity approach.

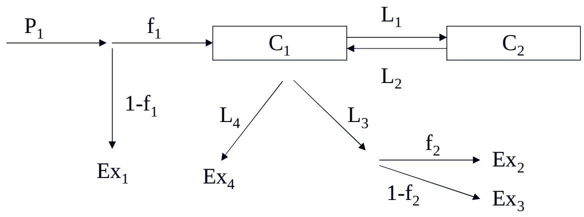

Fig. 1 Compartment model for metabolism in beef cattle and milking cow.

C1: carbon pool of low molecular weight, C2: carbon pool of high molecular weight, P1: carbon intake, f1: fraction of absorption, f2: fraction to urea and methane, L1: transfer rate, L2, 3: excretion rate, L3: breakdown rate, L4: transfer rate to milk (in case of cow), Ex1: feces, Ex2: urine, Ex3: breath, Ex4: milk (in case of cow) .

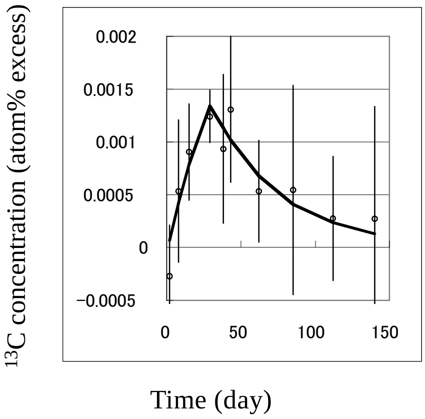

Fig. 2 Temporal change in ^{13}C concentration in beef accompanied by the continuous ^{13}C administration during 28 days.

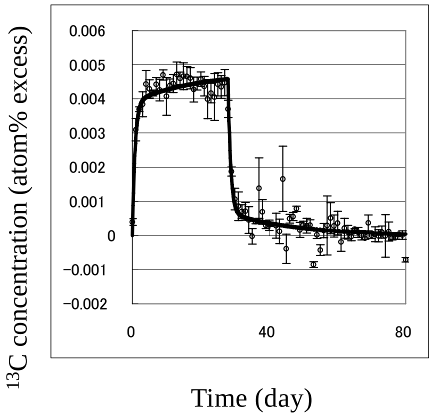

Fig. 3 Temporal changes in ^{13}C concentration in milk accompanied by continuous ^{13}C administration during 28 days.

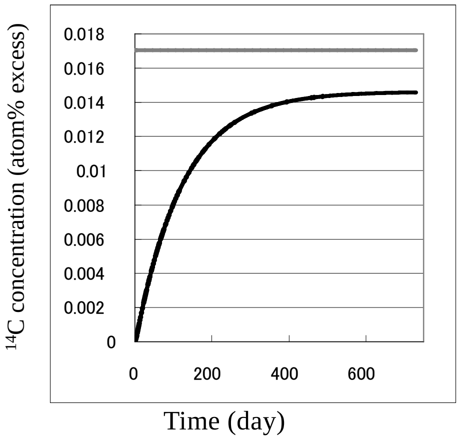

Fig. 4 Comparison of the expected ^{14}C concentration in beef.

Black line: Cattle and cow carbon metabolism. model, Gray line: conventional model.

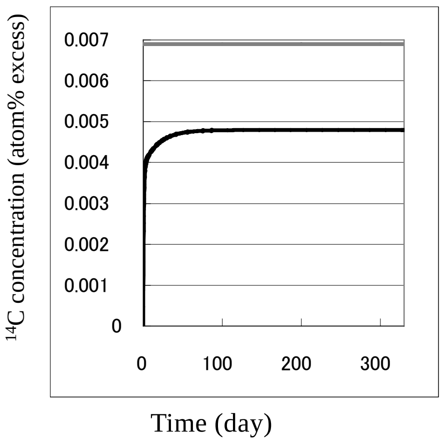

Fig. 5 Comparison of the expected ^{14}C concentration in milk.

Black line: Cattle and cow carbon metabolism model, Gray line: conventional model.