Study on Carbon Metabolism in the Human Body - Excretion of Carbon after Ingestion of Fat and Sugar

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Abstract

In the safety assessment made around the spent nuclear fuel reprocessing plant in Rokkasho, Aomori, ^{14}C is expected to be the biggest contributor to radiation dose received by the neighboring population, among radioactive nuclides released from the plant. The radiation dose due to ^{14}C reaches up to about one third of the total annual radiation dose which is estimated as 22 μSv. However, the estimate of ^{14}C dose is thought to be rather conservative, because of overestimation of ^{14}C dose conversion factor. The overestimation of the dose factor might be largely due to excessive simplification of the metabolic model of ^{14}C in the human body. The objective of the present study is to clarify the carbon metabolism experimentally, especially the biological half-time, of ^{14}C in the human body. In the experiment, stable carbon isotope (^{13}C) was used as a substitute tracer for ^{14}C. Following previous experiments on carbon metabolism through ingestion of protein, the carbon dynamic in the human body was examined after ingestion of fat and sugar.

Changes in ^{13}C isotopic ratios were measured in breath air, urine, feces and serum in three adult males over 16 weeks after oral administration of ^{13}C-u-palmitic acid and glucose, respectively. The amount of ^{13}C administered corresponded to 1,000 mg of ^{13}C each, in both experiments using palmitic acid and glucose, independently. The isotopic ratios of ^{13}C in breath air showed the highest value immediately on the day of administration of the chemicals, while those in urine, feces and serum had the highest values one day later after the administration. After showing the highest values, ^{13}C isotopic ratios in all of these materials gradually decreased. The changes in ^{13}C isotopic ratios were characterized by exponential functions of time having two components, for the ingestion of both chemicals. The retention times of these two components were estimated to be 1.3 and 35 days for breath air, 0.65 and 41days for urine, and 2.0 and 110 days for serum, respectivel, for the ingestion of palmitic acid. Those for the ingestion of glucose were 0.67 and 21 days for breath air, 0.67and 23 days for urine, and 3.0 and 19 days, respectively.

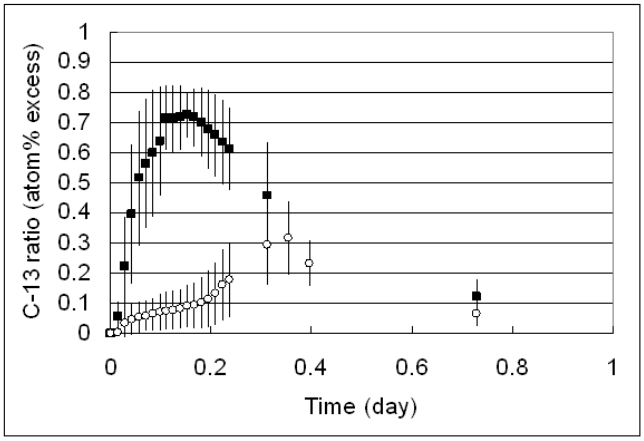

Fig. 1 Changes of ^{13}C ratio in breath (24 hours).
■: Glucose, ○: Palmitic acid.

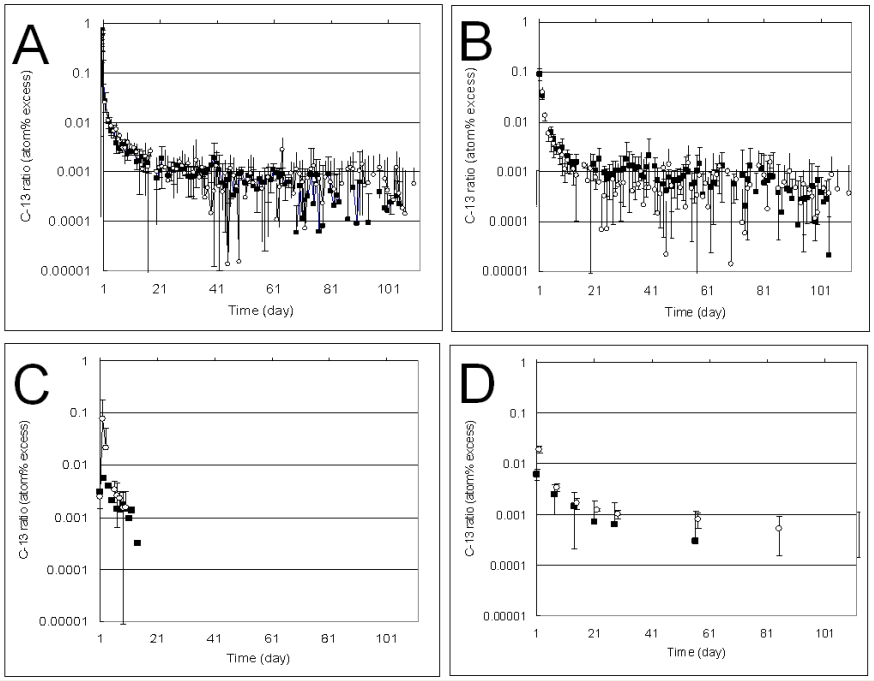

Fig. 2 Changes of ^{13}C ratio during 4 months after administration.
■: Glucose, ○: Palmitic acid. Panel A: Breath, B: Urine, C: Feces, D: Serum.

Table 1 Half-lives of ^{13}C enrichment (days).

		Phase I	Phase II
Palmitic acid	Breath	1.3	3.5×10
	Urine	6.5×10^{-1}	4.1×10
	Serum	2.0	1.1×10^{2}
Glucose	Breath	6.7×10^{-1}	2.1×10
	Urine	6.7×10^{-1}	2.3×10
	Serum	3.0	1.9×10