Transfer of ^{99}Tc from Soils to Rice and Upland Crops

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Introduction

- The fission yield of ^{99}Tc is comparatively high – 6%.
- A beta emitter whose half life is very long – 2.1 x 10^5 years.
- Environmentally very important in the RW disposal.
- Its release into the environment can also occur by spent-fuel reprocessing and reactor accidents.
- *Greenhouse experiments on the transfer of ^{99}Tc from soils to various crop plants to acquire TF (transfer factor) values for use in the ingestion dose assessment.*

Materials & Methods

Experimental soils & ^{99}Tc labeling

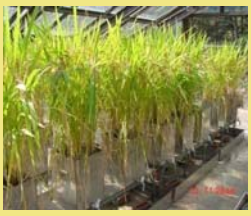
- Eight different soils collected around a nuclear site in Korea

Soil code	pH (1:5)	OM (%)	Clay (%)	Texture
A	5.5	3.7	11.0	Loam
B	5.1	4.2	15.4	Silt loam
C	5.6	3.0	26.9	Loam
D	5.1	4.9	25.2	Loam
E	6.7	5.2	14.0	Silt loam
F	6.1	5.6	12.4	Sandy loam
G	4.7	2.3	26.5	Loam
H	7.2	2.6	32.9	Clay loam

- Premix of 400 g dry soil and 30 ml ^{99}Tc solution
- 240 kBq ml^{-1} for rice and 23 kBq ml^{-1} for upland crops.

- Mixing the premix and the main volume of soil
- 352 kBq kg^{-1}-dry soil for rice and 35 kBq kg^{-1}-dry soil for others.

Plant culture



Sampling & measurements

- Harvested at edible maturities.
- Activity analyses by total beta counting for powder or ash samples
- Plant uptake was quantified with a transfer factor (TF, dimensionless) defined as follows;

$$TF = \frac{Plant\ concentration\left(Bq kg^{-1}\right)}{Soil\ concentration\left(Bq kg^{-1} - dry\right)}$$

Results of the Experiments

^{99}Tc transfer to rice (dry)

Soil	TF value (dimensionless)	
	Brown rice	Straw
A	1.4 x 10^{-3}±5.3 x 10^{-4}	1.0 x 10^{0}±2.2 x 10^{-1}
B	2.5 x 10^{-3}±6.8 x 10^{-4}	1.3 x 10^{0}±9.5 x 10^{-2}
C	5.4 x 10^{-4}±2.6 x 10^{-4}	5.3 x 10^{-1}±9.7 x 10^{-2}
D	8.4 x 10^{-4}±3.7 x 10^{-4}	6.6 x 10^{-1}±2.5 x 10^{-1}
AM±SD	1.3 x 10^{-3}±9.4 x 10^{-4}	8.8 x 10^{-1}±3.6 x 10^{-1}
GM / GSD	1.1 x 10^{-3} / 1.92	8.3 x 10^{-1} / 1.52

^{99}Tc transfer to soybean (dry)

Soil	TF value (dimensionless)			
	Seed	Shell	Stem	Leaf
E	1.6 x 10^{-1}	6.7 x 10^{0}	1.3 x 10^{1}	-
F	2.0 x 10^{-1}	9.5 x 10^{0}	2.1 x 10^{1}	1.2 x 10^{2}
AM	1.8 x 10^{-1}	8.1 x 10^{0}	1.7 x 10^{1}	-

^{99}Tc transfer to radish

Soil	TF value (dimensionless)			
	Root (fresh)	Leaf (fresh)	Root (dry)	Leaf (dry)
G	8.0 x 10^{-1}	3.1 x 10^{1}	1.1 x 10^{1}	3.5 x 10^{2}
H	1.0 x 10^{0}	2.6 x 10^{1}	1.3 x 10^{1}	3.0 x 10^{2}
AM	9.0 x 10^{-1}	2.8 x 10^{1}	1.2 x 10^{1}	3.2 x 10^{2}

^{99}Tc transfer to Chinese cabbage

Soil	TF value (dimensionless)	
	Leaf (fresh)	Leaf (dry)
G	1.1 x 10^{1}	1.4 x 10^{2}
H	8.8 x 10^{0}	1.2 x 10^{2}
AM	9.6 x 10^{0}	1.3 x 10^{2}

Summary & conclusions

- Much higher transfers were observed for the upland crops than for the paddy rice, which was grown in anaerobic conditions ($TcO_4^{-1} \rightarrow TcO_2$).
- Seed TF values were much lower than those of other above-ground parts indicating a very low mobility of ^{99}Tc to seeds.
- The GMs for the rice and the AMs for the upland crops are recommended for a temporary use in Korean food-chain dose assessment.
- IAEA values (TRS-472) for rice and vegetables are considerably different from the present values indicating the necessity of using as many site-specific data as possible.

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