Study on accumulation of ^{137}Cs in aquatic organisms

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Abstract The organisms were cultivated for 7 d in well water contaminated with ^{137}Cs. The experimental results show that the accumulation level of tissues of carassius auratus had the order of gill> viscera> epidermis (including scales)> bone (including head and tail) > flesh. The concentration capability of them had the order of shrimp > carassius auratus> ophiocephalus argus. The concentration factors (CF) of shrimp was 12.6 times of that of ophiocephalus argus.

Keywords Concentration factor, Aquatic organisms, Tissue distribution of ^{137}Cs

1 Introduction

^{137}Cs is one of the primary fission products discharged into environment at nuclear accident. Because of the long half-life it has aroused the great interest to population. Its existing in environment besides the nuclear accident and nuclear weapon tests is from the coal-fired power plants and nuclear facilities.

To accurately analyze the potential pathways of ^{137}Cs to man and calculate the dose of those to man many authors have compiled the concentration factors (CF) from the published literature.[1,2]. But the data are much varied[1], especially for the fresh water organism. The environment sources (including water quality, physiochemical state of nuclides and species differences) may influence the data of CF. And calculating CF prefers the data of attached special factors (such as the quality of water and the feeding habits of the organisms) to the single datum. Some authors[3] reported the CF derived from stable element. The experience showed that the CF calculated from fallout-derived are 1-8 times greater than those calculated from stable cesium.[2] At present the scientists advocated to use the data of CF measured directly in field.

This study dealt with accumulation levels in organisms and concentration capability for ^{137}Cs, the tissues distribution of ^{137}Cs and the relationship between specific activity of ^{137}Cs in water and CF.

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2 Experimental method

The organisms used in this study were carassius auratus, ophiocephalus argus and shrimp. The organisms were contaminated alone with $^{137}CsNO_3$ purified from radioactive waste. The experiments were conducted under laboratory conditions. The methods of sample process and the calculating CF are as Ref.[4].

A low background gamma spectrometer with a PGe detector, the resolution of which was 1.95 keV, the relative efficiency was 40%, was used in sample analysis. Calibration of the spectrometer for energy and efficiency was accomplished with National Bureau of Standards reference mixed nuclides source. A special soft ware was used for data processing. The samples were counted for 21600-57600s.

3 Results and discussion

3.1 The data in Table 1 express that different species of organisms in the same environment have tremendously different accumulation contents. Undoubtedly, it is linked with the feeding habits and habitat. ^{137}Cs has the strong affinity for sorption to sediment. The shrimp is a benthic feeder. The adsorption of particulated materials on its surface can significantly influence the whole body concentration factor.[2] These factors unquestionably explain why the CF of shrimp was much higher than those of other. With regards to fish they have variety of species every one of which has its own feeding habits associated with the accu-

mulation contents of ^{137}Cs. The carassius auratus is a omnivorous fish species and ophiocephalus argus is a predatory species. Many studies[1,2] have reported that predatory species attain lower flesh concentrations of nuclide than omnivorous species do . The results from this study are coincident with them.

Table 1 Accumulation contents and concentration factors for ^{137}Cs in flesh of organisms

Organisms	Specific activity in water/Bq·kg^{-1}	Content in flesh/Bq·kg^{-1}	Concentration factor
Shrimp	$(1.984\pm0.022)\times10^3$	$(2.175\pm0.003)\times10^4$	$(1.096\pm0.017)\times10$
Carassius auratus	$(1.876\pm0.023)\times10^3$	$(1.591\pm0.014)\times10^3$	0.848 ± 0.013
Ophiocephalus argus	$(3.548\pm0.045)\times10^2$	$(3.093\pm0.101)\times10$	0.087 ± 0.003

3.2 Accumulation contents and CF for ^{137}Cs in flesh of carassius auratus vs the specific activity of ^{137}Cs in water are summarized in Table 2. The value of accumulation is increased with the increasing of the specific activity of ^{137}Cs in water. And the CF is decreased with the increasing of the specific activity in water. Generally, the radioactivity used in laboratory is several orders of magnitude higher than those in field. Therefore, it is natural that the CF from our study is lower than CF derived from field data.[1]

Table 2 Accumulation contents and concentration factors for ^{137}Cs in flesh of carassius auratus as a function of specific activity in water

Specific activity in water/Bq·kg^{-1}	Content in flesh/Bq·kg^{-1}	Concentration factor
$(187.6\pm2.3)\times10$	$(159.1\pm1.4)\times10$	0.848 ± 0.013
$(120.3\pm0.8)\times10$	$(116.9\pm0.7)\times10$	0.972 ± 0.009
185.4 ± 3.9	221.0 ± 5.7	1.192 ± 0.040
54.7 ± 2.3	51.4 ± 2.6	0.939 ± 0.062

3.3 The results of tissue distribution of ^{137}Cs in carassius auratus are summarized in Table 3. The data show the tissue distribution of ^{137}Cs had the order of gill > viscera > epidermis > bone > flesh. The tissue distribution results of nuclides are expressed as $(SA)_r$=[specific activity in tissue, Bq/kg]/[specific activity in flesh, Bq/kg]. The tissue distribution of ^{137}Cs did not vary greatly. Therefore, for simplicity the CF of flesh may be applied to whole fish and tissues.

Table 3 Distribution for ^{137}Cs in tissues of carassius auratus

Tissue	flesh	bone	epidermis	viscera	gill
$(SA)_r$	1.00	1.50	1.57	1.70	2.57

3.4 The isotope Cs is not required biologically. It is concentrated by fish probably because of its chemical similarity to potassium. The potassium existing in water would influence the uptake of ^{137}Cs in fish. In this study the water quality had been analyzed. The potassium level is 13.9 μg/ml.

4 Conclusion

4.1 The concentration capability of organisms for ^{137}Cs may vary from species to species. And it has the order of shrimp > carassius auratus > ophiocephalus argus.

4.2 The tissue distribution of carassius auratus for ^{137}Cs has the order of gill > viscera > epidermis (including scales) > bone (including head and tail) > flesh.

4.3 The content of ^{137}Cs in flesh is increased with the increasing of the specific activity in water. And the CF is decreased with the increasing of the specific activity in water.

References

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