A Comparative Study on Environmental Radioactivity in Shellfish Inhabiting the Coasts of Korea and Japan

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ABSTRACT

To examine inshore radioactive contamination caused by nuclear power plants, both gross β -radioactivity and γ-spectrometry was measured. The measurements were taken with the sea mussels, *Mytilus coruscus* and *Mytilus edulis*, which had been collected from the four different sites of nuclear power plants (Kori, Ulchin, Wolsong, and Younggwang), and Jeju-do as a control site. As a result, the gross β -radioactivity observed was similar to that in nature. Among radionuclides, only ^{137}Cs, ^{40}K, ^{7}Be and ^{60}Co were detected in a very small amount, and each was also close to the natural levels.

Key words : environmental radioactivity, gross β-ray, gross β-radioactivity, radionuclides, γ-spectrometry.

INTRODUCTION

Korea and Japan both pursue, as their basic policies, the use of nuclear power as a major source of energy. At present, approximately 50% of the total electricity is derived from nuclear power in Korea, and approximately 30% in Japan. It is expected that the dependency on nuclear power will keep increasing in both countries.

In order to ensure sound development of nuclear energy, it is essential to provide for the safety of nuclear reactors. Beside, it is also important to prevent radioligical contamination of the areas surrounding nuclear power plants. Accordingly, it is necessary to regularly measure environmental radioactivity in the areas surrounding nuclear power plants, and to monitor, at all time, the levels of radioactive pollution caused by the plants. Both Korea and Japan have, in this respect, tight rigid environmental radioactivity monitoring programs.

The objects of environmental radioactivity monitoring are very diverse, including water samples(fresh water and sea water), soil sample, agricultural products, livestock products and marine products, and decision on which sample to analyze is made according to the geographic characteristics surrounding a specific power plants site. Marine products are classified into fish, seaweeds and shellfish, and the factors that affect sample selection are, radiation dose evaluation and index value, for example, whether or not the subject marine products are used as food, and low large is the concentration factor with respect to certain radioactive element.

Of shellfish, mussels are considered as an important index organism in most environmental pollution research, especially heavy metals. This is because mussels have very high concentration factors for heavy metals. They are also taken as an important index organism even in environmental radioactivity research.

The purpose of this paper is to investigate the environmental radioactivity of the mussel samples taken from the sea coast around the 4 nuclear power station: Kori, Wolsong, Ulchin and Younggwang stations. A mussel sample was also taken from the sea coast around Chuja-do which is located about 40 ㎞ from Jeju Island as a background.

MATERIALS AND METHODS

Sample collection and pretreatment

Samplings had been conducted from April 6~30,

1992. For each station, the sampling points covered the coastal area with distances between 700 and 1000m from the cooling water outlet and the depth of about 3m below sea level. The sampled specimen was either *Mytilus coruscus* or *Mytilus edulis* of 4 to 8㎝ in length. Each sample had a wet weight of about 4.5㎏. The Chuja-do sample was used as an uncontaminated reference.

The whole samples were first loosely washed in water and the heated in steam. After the shells has been removed, the soft tissue of each sample was dried for 12h and then pulverized in a mortar, γ-ray spectrometry was conducted on the dried samples using a Ge detector. A part of the dried sample was carbonized by heating for h at 650℃ in the electric oven, and used for the gross β-ray counting.

Gross β-ray counting

0.5g of the carbonized sample was put into a planchette of 1 inch diameter, followed by addition of 2 or 3drops of 10v/v% collodion solution(alcohol solution), and then dried under an infrared lamp. After the sample had been dried, the planchette was coated with mailler. Measurements were made of the gross β-rays for sample on the planchette.

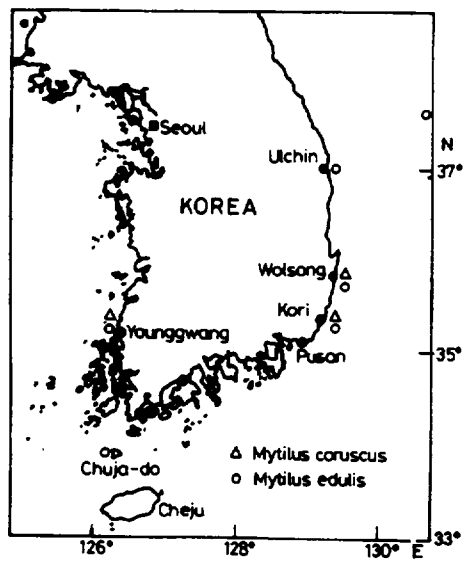

Fig. 1. Sampling locations of mussels

1.0g of potassium chloride(KCl) was prepared for the standard source in the way as the sample. Background was determined for a empty planchette.

The detector employed was a 2π gas flow-type GM counter(ALOKA LBC-451) for low-background β-counting, and the flow gas was Q gas(mixture of helium and isobutane). The gas flow was regulated at a rate of 120bubbles min^{-1}, and high voltage was applied to the detector(160V). There 60min countings were made for each sample, and the average was taken.

The gross β-radioactivity of the sample was determined based on the following relation:

$$A_{sample} = (N_{sample}/N_{KCl}) \times A_{KCl} \times 2$$

where;

A_{sample} : Gross β-radioactivity of sample (Bq g^{-1})

N_{sample} : Net count rate of 0.5g sample

N_{KCl} : Net count rate of 1.5g KCl

A_{KCl} : ^{40}K β-radioactivity of 1.0g KCl (14.44Bq g^{-1} KCl)

Nuclide analysis

79.8~251.6g of the dried and pulverized sample was placed in a container made of polyethylene and measured for 72h, using the Ge detector(ORTEC).

Results and Discussion

Gross β-radioactivity

Table 1 shows the gross β-radioactivity of the shellfish takes from the coasts of the 4 nuclear power stations and Chuja-do, Korea. The Chuja-do data are assumed to stand for the background radioactivity of the shellfish inhabiting the Korea coast.

Though a direct comparison of the observed data may not be appropriate since there exist some differences in the concentration factors between shellfish species, it is noted that the nuclear power plants do not have significant effects on the shellfish β-radioactivity. It is necessary, however, that seasonal variations of the background radioactivity should be

throughly investigated for the future uses.

Table 2 shows the gross β-activity of marine products collected from the sea near Genkai nuclear power plant located at the north of Kyusyu Island, Japan, the coastal environment of which is very similar to that Korea considering the geographical situations of both countries.

The radioactivity of *Batillus cornutus* and *Spetifer virgatus* can be well compared with those of the Korean samples. It is noted in Table 2 that the radioactivity between 1977~1989 of the *Batillus cornutus* ranges from 81~150Bq kg^{-1} wet. The radioactivities of the Korean shellfish samples fall within this range on the whole. According to the results of surveys conducted over a long period of time with respect to the Genkai nuclear power plant, there is no manmade radioactivity contamination in this area. Accordingly, as far as gross β-radioactivity is concerned, it is considered that there is also a noticeable radioactive contamination over the sea around the nuclear power stations in Korea.

Nuclide analysis

Table 3 shows the results of the radionuclide

Table 1. Gross β-counts in shellfish at each spots in Korea (Unit : Bq kg^{-1} wet)

Points	Species	1990*	1991*	1992
Kori	*Batillus cornutus*	105.05±3.75	66.16±2.74	
	Mytilus edulis			47.36±1.13
Ulchin	*Mytilus coruscus*	25.40	42.20	74.52±1.55
Wolsong	*Mytilus coruscus*	56.84±20.58	40.65±7.10	
	Mytilus edulis			31.68±1.18
Yonggwang	*Mytilus coruscus*	70.77±33.00	72.90±12.58	
	Mytilus edulis			40.61±1.29
Chuja-do	*Mytilus coruscus*			49.09±1.05

*Determined by Korea Electronic power Co.

Table 2. Gross β-counts in marine products surrounding Genkai nuclear power plant at Saga, Japan (Unit : Bq kg^{-1} wet)

Marine products species	1989's		1977-1988's	
	Sample No.	Result	Sample No.	Result
Pagrus major	4	94~110	44	70~170
Stephanolepis cirrhifer	2	97, 85	22	78~110
saurida undosquamis	2	110, 100	21	96~130
Stichopus japonicus	2	20, 22	23	15~59
Todarodes pacificus	2	120, 92	22	74~170
Batillus cornutus	1	84	11	81~150
Spetifer virgatus	1	50	11	37~78
Undaria pinnatifida	1	190	11	200~270
Sargassum fulvellum	8	190~370	32	260~410

Matter: Saga Environmental Center.

Table 3. Radionuclide concentrations in shellfish at the Korean coast in 1992.

(Unit : Bq kg^{-1} wet)

Sampling point	Species	^{60}Co 1173KeV	^{60}Co 1333KeV	^{137}Cs	^{40}K	^{7}Be
Kori	*Mytilus edulis*	N.D.	N.D.	0.04±0.01	122±2	5.9±0.6
Ulchin	*Mytilus coruscus*	N.D.	N.D.	0.05±0.01	87±1	2.8±0.5
Wolsong	*Mytilus edulis*	N.D.	N.D.	0.05±0.01	61±1	6.8±0.7
Yonggwang	*Mytilus edulis*	0.03±0.04	0.03±0.04	0.10±0.02	64±1	5.4±0.5
Chuja-do	*Mytilus coruscus*	N.D.	N.D.	0.03±0.01	64±1	1.5±0.2
Genkai*	*Mytilus edulis*	N.D.	N.D.	0.04±0.01	37±1	3.9±0.1

N.D. : not detected.

*Matter: Saga Environmental center.

analysis carried out, using the Ge detector, with respect to the Korean shellfish samples. The results for the shellfish in 1992 from Genkai nuclear plants in Japan are also listed for comparison.

In general, the *Mytilus edulis* group shows a high concentration factor for the element cobalt[8]. Therefore, ^{60}CO from radioactive fallout from past nuclear tests has been found in shellfish occasionally[7].

Accordingly, whenever ^{60}CO is detected in shellfish inhabiting waters near a nuclear power plant, it is necessary to carry out more detailed analyses and determine whether the existence of ^{60}CO has been caused by nuclear weapon tests or by the nearby nuclear power plants.

According to a survey conducted by the Saga province of Japan since 1977, maximum radioactivity of 0.22 Bq kg^{-1} was reported with respect to *Spetifer virgatus*. Based on this fact, it is too early to conclude that the ^{60}CO traces shown in the *Mytilus edulis* living near Yonggwang have been caused by the power plants. At any rate, it is necessary to continue multidirectional investigations based on more related data.

The ^{137}Cs concentration in Korean shellfish is within the concentration ranges generally observed in shellfish, such as purplish bifurcate mussels, inhabiting the wafers around Japan.

Expect for the nuclides shown in Table 3, no manmade radioactivity nuclides, such as ^{90}Sr, ^{131}I or ^{54}Mn have been detected. Since ^{40}K and ^{7}Be are natural radioactivity nuclides, the concentrations are the same as those in shellfish inhabiting the waters around Japan (source: Saga province data).

Based on the ^{60}CO concentration as measured on the Yonggwang sample, for example, if a person consumes 10g of *Mytilus edulis* every day, the annual internal radiation dose would be 7.7×10^{-8}mSv. Because the normal annual radiation dose limit to a person is 5mSv, ^{60}CO concentration found in the *Mytilus edulis* inhabiting the Yonggwang coasts is extremely low. However, since shellfish is an important index organism of environmental contamination, continued study in this field is strongly recommended.

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Reference

Chang D.S. et al., Bull. Fish. Res. Dev. Agency, 38 (1986) 25.

Momoshima N. et al., Japan Radioisotopes, 34(5) (1985) 3.

Park C.K. Yang K.R, J. Korean Nuclear Society, 10(1) (1978) 13.

Goldberg E.D. et al., Radioactivity in the Marine Environment, National Academy of Science, Washington, D.C., 1971, pp. 137.

The Ministry of Sci. & Tech., White Paper of Nuclear Power Safety, 1992.

The Korea Industry Committee of Nuclear Power, Annual Report of Nuclear Power, 1990-1991.

Saga Pref. Environmental Center, Annual Report Environmental Radioactivity Survey of Genkai Nuclear Power, 1992.

Kagoshima Pref. Environmental Center, Annual Report Environmental Radioactivity Survey of Genkai Kawauchi Power, 1991.