Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 17-18, 2018

Radiological assessment from radioiodine analysis around nuclear facilities and sewage treatment plants

Min Ji Kim *, UkJae Lee, Hee Reyoung Kim
Ulsan National Institute of Science and Technology, Ulsan 689-798, Republic of Korea
**Corresponding author: minji4644@unist.ac.kr*

1. Introduction

The radioactive iodine ^{131}I is used for a variety of purposes such as metabolism, scintigraphy, and a tracer. Furthermore, in the medical field, ^{131}I is used for medical diagnosis and treatment of diseases such as hyperthyroidism [1]. Meanwhile, if ^{131}I is released into the general environment, environment can get damage. Not only the environment contamination but also the human body gets damage through respiration. As the radioactive iodine accumulates the thyroid gland, the gland cells die or mutates causing cancer consequentially. Thus, to protect human health, periodic monitoring of ^{131}I in the environment is necessary.

The Radioisotope Production Facility (RIPF), which is located within the Korea Atomic Energy Research Institute (KAERI), manages about 1,000 Ci of ^{131}I per year. Due to the nearness, the people in the surrounding nuclear facilities have been concerned about the leakage of radioactive substances. To alleviate this concern, at the Gap River, samples were collected from common elements of the ecosystem such as surface water, fish, aquatic plants, and sediments. This research is conducted for the analysis of the samples, which helps to track the origin of the ^{131}I.

2. Materials and Methods

2.1 Collection and pretreatment of samples

There are several kinds of environmental samples: surface water, fish, aquatic plant, and sediment. They are collected in the sampling points: KAERI's front gate, Donghwa bridge, Daejeon sewage treatment plant, front of the cogeneration plant, and Yongshin bridge. The samples from the Wonchon bridge upstream of the sewage treatment plant are used for comparative analysis. The Gongju reservoir, uncontaminated from radioactivity, at 22.85km far from RIPF, is the control site. The collection places are indicated in Figure 1.

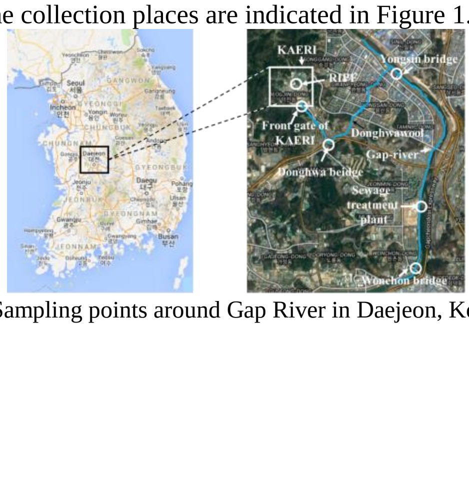

Fig. 1. Sampling points around Gap River in Daejeon, Korea

At each sampling point, samples of 20 L of surface water were collected on the middle of the water flow. They were vaporized and concentrated to 1 L.

In the Gongju reservoir, thought uncontaminated in terms of radioactivity, and at the sewage treatment plant, some fish samples were collected. After foreign substances were removed from them and they were weighed to be ground using a mixer. Aquatic plant samples were dried by using a dryer and ground by using a mixer. Then, they would be weighed again.

At about 5 m radius from each place, the sediment samples were collected. Before and after drying, they were weighed, and ground with a sieve. Then, they were crushed by using a mortar to estimate the fineness and located in U-8 vial to analyze gamma isotope.

2.2 Radioactivity analysis of ^{131}I

The net counting rate should be calculated for radioactivity analysis. First, under the same conditions the background counting factor was calculated, and then subtracted from the sample counting rate. Under the same conditions, as the sample measurement, the same empty container which has no radiation sources was measured. A gamma spectrometer measures the ^{131}I radioactivity of samples.

3. Results

3.1 ^{131}I concentration

Table I: The range and average ^{131}I concentration of surface water, aquatic plant, and sediment samples in the area

	^{131}I Concentration		
	Surface water (avg) [Bq/L]	Aquatic plant (avg) [Bq/kg-dry]	Sediment (avg) [Bq/kg-dry]
Front of main gate	<MDA	<MDA ~ 5.6(2.2) ± 0.952	<MDA
Donghwa bridge	<MDA	<MDA ~ 18.7(4.6)	<MDA
Wonchon bridge	<MDA	1.1 ~ 14.4(3.9) ± 0.615	<MDA ~ 3.0(2.27) ± 0.137
Drain of sewage treatment plant	0.34 ~ 3.21(1.07) ± 0.0756	27.9 ~ 627.6(282) ± 18.79	0.43 ~ 10.1(6.09) ± 0.55
Front of cogeneration plant	0.07 ~ 1.28(0.52) ± 0.0428	1.6 ~ 69.9(26.2) ± 8.158	<MDA ~ 4.7(2.16) ± 0.421

Table 1 shows the result of ^{131}I concentration of samples. Figure 2 indicates that ^{131}I in surface water was detected at the sewage treatment plant drain and the front of the cogeneration plant, but it was not detected at the KAERI's front gate or Donghwa bridge. MDA value is highest at each site. At the drain of sewage treatment plant and Yongshin bridge, ^{131}I concentrations were maximum 3.21 and 1.28 Bq/L respectively.

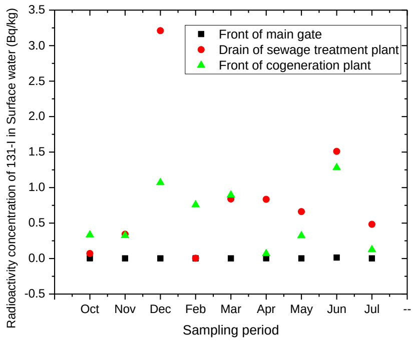

Fig. 2. Radioactivity concentration of surface water

^{131}I in all fish was detected at the drain of sewage treatment plant, but it was not detected at the Gongju reservoir. This means that ^{131}I passed through Gap River.

Figure 3 indicates that ^{131}I in aquatic plants was detected at the drain of sewage treatment plant and the front of cogeneration plant. At the drain of sewage treatment plant, ^{131}I concentration mostly had the highest value, which was seven times higher than those at the KAERI's front gate and Donghwa bridge.

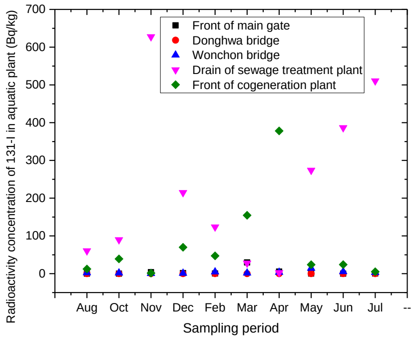

Fig. 3. Radioactivity concentration of aquatic plant

Figure 4 indicates that ^{131}I in sediment was detected at the drain of sewage treatment plant, and front of cogeneration plant. The former had more than the latter. At the Wonchon bridge, ^{131}I was also detected but a little. In other hand, at the KAERI's front gate and Donghwa bridge, ^{131}I in sediment was not detected.

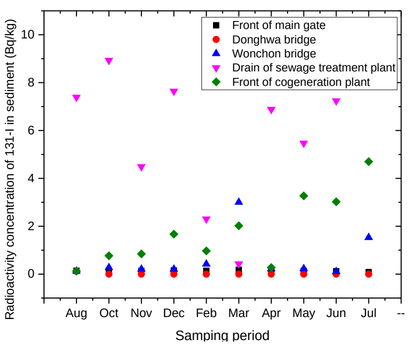

Fig. 4. Radioactivity concentration of sediment

3.2 Analysis of outbreak location and contamination of ^{131}I

Sewage from Daejeon city, such as radioactive iodine for diagnostic purpose from hospital, is collected at the sewage treatment plant. The results of ^{131}I concentration show that ^{131}I was mostly detected at the drain of sewage treatment plant. Especially, in all fishes it was detected at the downstream of the plant, not at upstream of the plant, like Wonchon bridge, and the Gongju reservoir. That is, the fish were detected due to ^{131}I-contaminated river water. At the KAERI's front gate and Donghwa bridge, however, ^{131}I was not detected That is, ^{131}I detection in the Gap River has no relation with RIPF. It is because of the direct release of excretion by the patients diagnosed by radioactive iodine, and the accumulation of ^{131}I in the aquatic plants.

The internal exposure of ingestion of fish can be calculated as the product of dose coefficients (2.2E-8 Sv/Bq for the ingestion of ^{131}I for adults of the public up to 70 years of age [3]) and radioactivity concentration (8.26 Bq/kg, which is the highest value of the aquatic plants) and annual supply of fish per capita (24.5 kg in 2015 [4]). Thus, the value is 0.0045 mSv/year, less than the legal limit of internal exposure due to the ingestion of fish (1 mSv/year). The legal limit for food of the radioactive concentration is 100 Bq/kg. All the fish samples have lower than limit, about 1/12.

4. Conclusions

Because of an increase in medical use of the ^{131}I, it flows rivers through the sewage treatment plants. The radioactive iodine (^{131}I) concentration from this study showed that it did not enter the river from the RIPF. Besides, sewage from RIPF was analyzed and confirmed whether the nuclide is detected or not. Thereafter, it moved to the wastewater treatment facility.

It was seen the hazardous ^{131}I could have entered through the wastewater of facilities like hospitals, not RIPF. We hope that the public acceptance of ^{131}I from the RIPF to the environment would be better.

REFERENCES

[1] H. Maxon 3rd, E.E. Englaro, S.R. Thomas, V.S. Hertzberg, J.D. Hinnefeld, L. Chen, H. Smith, D. Cummings, M.D. Aden, Radioiodine-131 therapy for well-differentiated thyroid cancer--a quantitative radiation dosimetric approach: outcome and validation in 85 patients, Journal of nuclear medicine: official publication, Society of Nuclear Medicine, Vol. 33, No. 6, pp.1132-1136, 1992.

[2] Z.M.M. Houmani, A.A. Majid, S. Radiman, Z. Ahmad, Sorption coefficients of 137 Cs onto various Malaysian soil series, Malaysian Journal of Analytical Sciences, Vol. 16, pp.157-162, 2012.

[3] K. Eckerman, J. Harrison, H. Menzel, C. Clement, ICRP publication 119: compendium of dose coefficients based on ICRP publication 60, Annals of the ICRP, Vol. 42, e1-e130, 2013.

[4] K.F.B. Sheet, Korea Rural Economic Institute, Seoul, Korea, pp.145-146, 2008.