BE-7 CONCENTRATIONS IN GARDEN AND WILD VEGETABLES IN JAPAN

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INTRODUCTION

Beryllium-7 is a natural radionuclide produced by cosmic rays(1). Be-7 is found vividly in the atmosphere, so the concentrations in airborne particles were analyzed by many investigators(2-3). It is known that airborne particles with Be-7 in the atmosphere fall slowly to the ground and adhere to plant surface. However, Be-7 concentrations of foods were not measured too much. So we measured Be-7 concentrations of garden vegetables, wild vegetables, grasses, beef and milk, and calculated internal exposure dose from Be-7.

EXPERIMENTAL

Eleven species of garden vegetables (carrot, Japanese radish, cabbage, Chinese cabbage, spinach, cucumber, broccoli, etc.) and three species of grasses were collected from a farm in Towada city of Aomori Prefecture, and ten species of wild vegetables (*Anemone flaccida, Aralia cordata, Aralia elata, Cacalia hastata, Cardiocrinum cordatum var glehnii, Laportea macrostachya, Matteuccia Struthiopteris, Petasites japonicus, Pilea hamaoi, Pteridium aquilinum*) were gathered in a forest area of Mt. Hakkoda of Aomori. Beef and milk samples produced in Aomori were purchased at a store. As beryllium is scarcely scattered by heating, these samples were burned out to dry ash at 400 ℃ for 30hours using an electric furnace. The preprocessed samples were packed compactly into plastic vials, and counted for 24 hours using a Canberra 30% HPGe detector coupled a Canberra Series 35plus MCA. The surface areas of leaf were calculated by counting pixel numbers of picture using computer. Internal exposure doses from Be-7 in foods were obtained by S-value of MIRD Pamphlet(5) and the metabolic data of ICRP(6).

RESULTS AND DISCUSSION

Beryllium-7 concentrations of plant samples are shown in Table 1. Beryllium-7 concentrations of garden vegetables were from 0.2 to 25.3 Bq/kg, and concentrations of wild vegetables were from 0.8 to 23.5 Bq/kg. There is no difference in Be-7 concentrations between garden vegetables and wild vegetables. Leaf vegetables have almost higher concentration of Be-7. Though *Matteuccia Struthiopteris* and *Pteridium aquilinum* are ferns, their eatable stages are sprouts.

Figure 1 shows relationship between surface area and Be-7 concentration in some vegetable leaves gathered simultaneously at the same farm. Beryllium-7 concentrations of leaves correlate significantly with the surface area/weight ratios. What high concentration vegetables have proportionately broad leaves suggests that atmospheric Be-7 particles adhere to surface of leaves.

As grasses have the higher surface area/weight ratios, their Be-7 concentrations (especially timothy) were very high. Figure 2 shows relation between ablution frequency and Be-7 concentrations of leaves when these grasses were washed by a synthetic detergent. Beryllium-7 concentrations of grasses fell markedly after first washing. However, these concentrations were not decreased after second, third and fourth washing respectively. This fact was found similarly in other vegetables. A binding portion of Be-7 should be on the leaf or in the leaf. Beryllium-7 concentrations of root vegetables and cucumber were very low level, and concentrations Be-7 in peeled vegetables were still lower. Consequently, it is supposed that the plants have little ability to absorb beryllium from roots.

There are probably two components of Be-7 that loosely adhere to the outside of vegetables and firmly cling to that.

Concentrations of Be-7 in beef and milk were all under limit of detection. As the concentrations of Be-7 in grasses were high, it was guessed that transfer coefficient of Be-7 to beef and milk from feed is very low. Therefore it is thought that contribution to internal exposure from Be-7 in beef and milk is negligible.

Table 1. Be-7 concentrations in vegetables.

Garden vegetables	
Broccoli	1.1
Cabbage	8.7
Carrot (leaf)	25.3
Carrot (root)	0.4
Chinese cabbage	11.2
Cucumber	0.2
Japanese radish (leaf)	10.4
Japanese radish (root)	0.2
Spinach	5.0
Wild vegetables	
Anemone flaccida	20.9
Aralia cordata	1.0
Aralia elata	4.1
Cacalia hastata	13.4
Cardiocrinum cordatum var glehnii	2.2
Laportea macrostachya	7.8
Matteuccia Struthiopteris	1.7
Petasites japonicus	23.5
Pilea hamaoi	9.2
Pteridium aquilinum	0.8

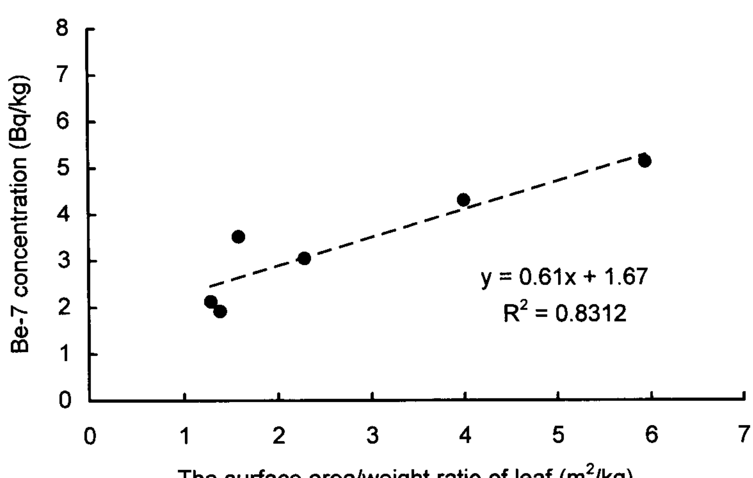

Figure 1. Relationship between surface area and beryllium-7 concentration in some vegetable leaves.

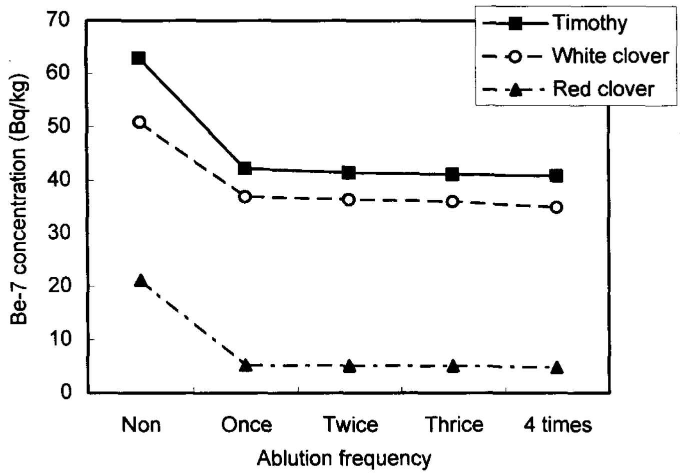

Figure 2. Deciduation of beryllium-7 from leaves by washing.

Beryllium-7 is taken in the body via the respiratory organ and gastrointestinal system, and contributes to internal exposure. Though there are very little reports on internal exposure from Be-7 in food, NCRP reported on the exposure dose from Be-7 in leaf vegetables as 8μrad/yr(80nGy/yr) and on the dose conversion factor to exposure as 2.7×10^{-9} mrad/pCi intake (0.73pGy/Bq).

We tried to evaluate the internal exposure from Be-7 in vegetables above-mentioned. Hypothetical Japanese annual intake amounts of leaf vegetables and wild vegetables are 35 kg/yr and 3 kg/yr respectively. The absorption coefficient of GI tract f_1 is 0.006, and absorbed Be-7 deposit in bone (6). The retention periods of stomach, small intestine, upper large intestine and lower large intestine were used for calculation as 1, 4, 13 and 24 hours respectively. Finally we obtained the dose conversion factor from the S value (5) as 7.8 pSv/Bq. We used the higher concentration values (leaves of carrot and *Petasites japonicus*) for calculation, then we obtained the internal exposure dose 7.5 nSv/yr.

Though the dose conversion factor in this study was ten times higher than NCRP report, the evaluated internal exposure dose was ten times lower than NCRP. If the dose conversion factor of NCRP, our concentration values and the annual intake amounts are used, calculated internal exposure dose is a hundred times lower than NCRP.

REFERENCES

1. E. Merril, Environmental Radioactivity 3rd Ed., 155-157 (1987)
2. A. Bouville, Radioprotection 20, 21 - 31 (1985)
3. G. C. Christensen and R. Mustonen, Radiat. Prot. Dosim.21,.125 - 128 (1987)
4. National Council on Radiation Protection and Measurements, Natural Background Radiation in the United States, NCRP report No.45, 34-43 (1975)
5. MIRD Pamphlet, No.11 (1975)
6. ICRP, Publication 30, Part 3, 5-9 (1978)