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Investigation of I-125 Uptake in Five Different Plants

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ABSTRACT

Background: Radioiodine 125I is an environmental contaminant that humans may consume in edible plants. The characteristics of 125I in plants are poorly understood.
Objectives: This study examined 125I concentrations in the edible parts of five types of plants from different locations on farms with a similar climate. Near Zahedan, Iran.
Materials and Methods: The experiments used a mini-column approach in which more realistic conditions than those of the batch-sorption technique were maintained. Twenty sub-samples from the leaves and stems of five different plants (sugar beet, turnip, alfalfa, oat and bamboo) were obtained, and 445 Bq of 125I was added to the plants.
Results: Immediately, and after one month, 500 g of each wet plant sub-sample was placed in a test tube, and the 125I contents of the stem and leaves were measured for 20 s by a gamma ray counting machine. The 125I concentration either increased or was reduced in the edible parts of the plants. More radioactive adsorption occurred in the leaves than in the stems in all cases.
Conclusion: Radioiodine concentrations depended upon the type of plant. Such knowledge of the physicochemical characteristics of radioiodine adsorption in plants is essential for estimating the behavior of the iodide group, especially the transfer of 129Ito other systems.

Implication for health policy/practice/research/medical education:
There were not instrument to measure radio iodine concentration in samples.

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1. Background

Radio nuclides are widely used in medical institutions for routine diagnosis and therapy and also in research as tracers in animals and humans; thus, the amount of radionuclide waste in the environment is increasing. Consequently, radioactive deposits in the ground are inevitably also increasing. The concentration of radioactive pollutants need to be measured, and the disposal of radionuclide waste must be submitted to the appropriate pollution inspectorate to ensure compliance with radioactive substance regulations governing laboratory use and environmental safety in each country (1). Vegetables that have been contaminated by radio nuclides result in human exposure via the food chain (2). Radioiodine, an important group of radionuclide, is a volatile product of nuclear fission that can cause thyroid cancer as a result of accumulation in the thyroid glands (3-5). Radioiodine 125I, which is a surrogate for 129I, has a half-life of more than 106 years and persists for a long time in the atmospheric environment. Its volatility provides a significant pathway for the trans-

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port of 129I (6). The excess lifetime cancer risks due to 129I were found to be higher than the world average in samples from several areas (7, 8). In addition, plants used as foods absorb mineral materials directly or indirectly (9). These materials may be taken up by the leaves of plants.

Radioiodine absorption by plants from air polluted by radioactive materials could be significant. Several factors influence the absorption of radioactive materials through the leaves of plants, including the amount of radioactive elements (10), the degree of mixing of radioactive materials and the rate of absorption (11), the activity of micro-organisms (12), and selective absorption by the leaves of plants (13). The Health Ministry of Japan detected higher-than-normal levels of 131I in spinach samples collected from farms in six locations in the Ibaraki Prefecture, south of Fukushima. One spinach sample collected from the city of Hitachinaka, located about 120 km south of the plant, contain 8420 Bq/kg of 131I, according to the Health Ministry. The normal amount set by Japanese law is 2000 Bq/kg. Another spinach sample from Takahagi, a city closer to Fukushima, contained 15020 Bq/kg, more than seven times the normal amount. Strong specific sorption of iodine to humic substances, which was reduced at freezing temperatures, was demonstrated. Rapid sorption to wet substances is believed to significantly reduce the volatility rates. The effect of freezing on iodine suggested a microbially mediated sorption process (14).

2. Objectives

The objective of the study was to measure the concentration of radioiodine 125I deposited on vegetables and subsequent levels over a period of time. The data were useful for estimating the amount of radioiodine which accumulated in the plants during the course of the study. We assessed the deposition of radioiodine from both the laboratory and other sources into plant systems.

3. Materials and Methods

Five types of vegetation were chosen for testing. Two were grasslands, and a third was grassland with a richer species composition than the primary grasslands. The other two were grassy swards dominated by a somewhat less acidic species. The sampling had the following limitations; (a) it was known that spatial variability could be important,(b) the sampled area should not be too large, and (c) counting facilities and hence sample numbers, were limited. For these reasons, the sampling consisted of an area of 50×50 m², and sampling was restricted to a single area of 1×1 m² at each visit. All areas were marked with wooden pegs to aid in relocation.

A vegetation sample consisted of a 1×1 m² area. Sub-samples were placed in test tubes, and a few drops of 125I were added to them. The 125I concentrations of each tube for any part of the plants were measured after 24 h, and after one month (15). Radioiodine 125 in the plant was measured by a gamma counting machine (Automatic Gamma Counting system, Serial No. GM1 8335 S 307, KONTRON, Switzerland). Most studies on radionuclide deposition and subsequent weathering from vegetation have been performed on plants in a laboratory, where conditions were very similar to those in the area of vegetation (11). Monitoring was terminated when the samples were completely consumed. Three samples for the leaves and stem of each plant were prepared. A duplicate sub-sample of plants was examined; the resulting relative error due to homogenisation and analysis was less than 10%.

4. Results

The radioiodine contaminant showed essentially no rapid early loss, decaying with an effective half-life close to the physical decay rate. Immediately after 125I was added, the plant stem activity ranged from 3×103 for the stem of sugar beets to 39×103 counts/min for bamboo respectively (*Table 1*). After one month, the concentrations were 30 and 390 counts/min in the stems of these plants respectively, although considerable variation among the plants was observed (*Table 2*). The initial 125I concentrations in the leaves of alfalfa and bamboo were 2325 and 56.2×103 (*Table 1*) counts/min. After one month, the values were 560 and 23 counts/min, respectively (*Table 2*).

Table 1. Initial Concentration of 125I in Each Plant Part in Counts/Min

	Type of Vegetation	Radioactivity in Case Sample , CPM	Radioactivity in Control Sample, CPM
Stem	Sugar beet	3000 ± 50	100 ± 12
	Turnip	3960 ± 168	20 ± 0.15
	Oat	16250 ± 80	24 ± 0.10
	Alfalfa	5000 ± 120	35 ± 0.80
	Bamboo	39000 ± 1000	45 ± 0.34
Leaf	Sugar beet	10000 ± 325	100 ± 0.54
	Turnip	12540 ± 200	38 ± 0.32
	Oat	11350 ± 170	41 ± 0.10
	Alfalfa	2325 ± 87	30 ± 0.30
	Bamboo	56200 ± 900	51 ± 0.63

Abbreviation: CPM, counts per minute

Table 2. Concentration of 125I in Each Plant Part After One Month in Counts/Min

	Type of Vegetation	Radioactivity in Case Sample , CPM	Radioactivity in Control Sample, CPM
Stem	Sugar beet	30 ± 0.50	200 ± 32
	Turnip	39 ± 10	75 ± 5
	Oat	162 ± 0.25	60 ± 6
	Alfalfa	50 ± 0.40	55 ± 6
	Bamboo	390 ± 100	40 ± 015
Leaf	Sugar beet	100 ± 0.45	100 ± 20
	Turnip	125 ± 0.58	70 ± 4
	Oat	113 ± 0.35	45 ± 14
	Alfalfa	23 ± 2	57 ± 0.90
	Bamboo	560 ± 10	55 ± 4

Abbreviation: CPM, counts per minute

Initially, the measured material consisted of both surface deposits plus any material taken up by other parts of the plant. After one month, the samples represented mainly material taken up by the plants, because during that time the majority of the previous growth would have become incorporated into the lower layers by decay in the air. The initial 125I concentrations in bamboo leaves and oat stems were 56.2 × 103 and 16.25 × 103 counts/min. It declined by almost an order of magnitude to 560 and 162 respectively. Although a continuous decline in concentration in the vegetation was occurring, this was interrupted by the growth cycles of the vegetation, during which concentrations increased due to plant uptake despite the diluting effects of plant growth. When 125I was considered in total, a decline of 100 counts/min in the stems and leaves of all five grasses occurred in each plant. By the end of the monitoring period, the amounts had fallen by about 10 counts/min order of magnitude.

5. Discussion

The 125I concentration in crops depends on a number of different factors (13). Dependence on the growth period in the five types of plants was complicated by the fact that these five types originated in different amounts at different times (16). Early in the study, surface deposition plus some plant uptake would account for the material measured in the crops, but the later values would be dominated by plant uptake. The 125I content was similar, but not identical for these species, and this indicated the presence of other material associated with the samples. The transfer factors of the leaves tended to be higher than those of tubers, fruits and grains (17, 18). The results might be due to the wide distribution of N-acetylchitooligosaccharide elicitor-binding proteins among various plants, which would add further support for the finding that these membrane proteins are active in the perception of the elicitor signal (19).

In the five plant systems, 125I might be removed in several ways (20); the most important of these might be leaching down the profile out of the organ and cell membrane zone, followed by removal by water in the plant. The water in the plant might make some contribution (21); suspension in all of the tubers was not impossible, but was likely to be minimal in the tuber habitats. Annual effective gamma doses were found to be higher than the world average in some samples (22). The radioiodine concentration in the solutions increased initially and then dropped. A comparison of *Tables 1* and 2 shows that desorption of radioiodine varies with the plant type. This research shows that the edible parts of plants can affect the activity of radioiodine 125I.

The concentration of radioiodine is known in the edible parts of the mentioned plants. Standards with specific levels which would result in diseases have not been determined for these plants; therefore, the relationship between diseases and health through the consumption of these plants still remains unclear. In the systems under consideration, the removal of 125I would be affected mainly by physico-chemical process, and biological processes would play a smaller role.

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None declared.

Authors' Contribution

Hosseini Seyyed abbas, designer of project; Hosseini Seyyed ali , cooperator of design; Rakhsh khourshid Atta allah, cooperator as Analysis of data.

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