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Estimation of uranium contents in different parts of the plants and soils

S Choudhury
Department of Botany, Pandu College, Guwahati-781 012, Assam, India
and
T D Goswami
Department of Physics, Gauhati University, Guwahati-781 014, Assam, India

Abstract : The method of particle track analysis has been used to estimate the uranium content in different parts of the plants and soils collected from respective plant habitats. The uranium content of the samples has been found to vary from 0.22 ppm (Wheat grain and root of Lamb's quaters) to 3.27 ppm (soil collected from below the banana plant). On the average the concentration in soil is found to be highest (2.67 ppm). Among the different parts of the plants the average uranium content is found to be highest in leaves (0.74 ppm) and lowest in fruits (0.45 ppm). The investigation may throw some light regarding the root uptake and foliar absorption of uranium into the plant body. Also it may furnish some information regarding the distribution of this radionuclide in different portions of the plants.

Keywords : U-content, trace element, plants, soils.

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1. Introduction

Uranium, the heaviest trace element in nature, is a normal constituent of all organisms (Gulati *et al* 1980). It is present as radioactive isotopes and are transported physically through environment and pass from the soils and plants to man. The presence of uranium in biological material even in traces may have some toxic effects (Tannenbaum and Silverstone 1951).

The cereals, pulses, underground vegetables, leafy vegetables and fruit vegetables are the most important sources of plant food for man. Most of the food consumed by human beings is grown on land and, except for elements like carbon and oxygen which may be obtained from the atmosphere, it is the soil that nourishes the complicated terrestrial ecological system of which man is a part. The radionuclide uranium occurs naturally in soil, is incorporated metabolically into plants and ultimately finds its way into the bodies of animals including man. In addition to root uptake of uranium, direct deposition may occur on foliar surfaces,

and when this happens the contaminants may be absorbed metabolically by plants. Much remains to be learned about the ways, this radionuclide behaves in passing from the roots to the eatable portions of the plant. The uranium contents of the eatable parts of different groups of food items have been published by the authors elsewhere (Choudhury and Goswami 1988).

The present investigation was undertaken to estimate the uranium contents in different parts of the plants and soil samples of the places where these plants were grown.

2. Experimental procedure

Samples of different plant materials and soils have been collected from the village Garal, Dalibari, Maligaon, Dt. Kamrup, Assam and Nongpoh, Meghalaya.

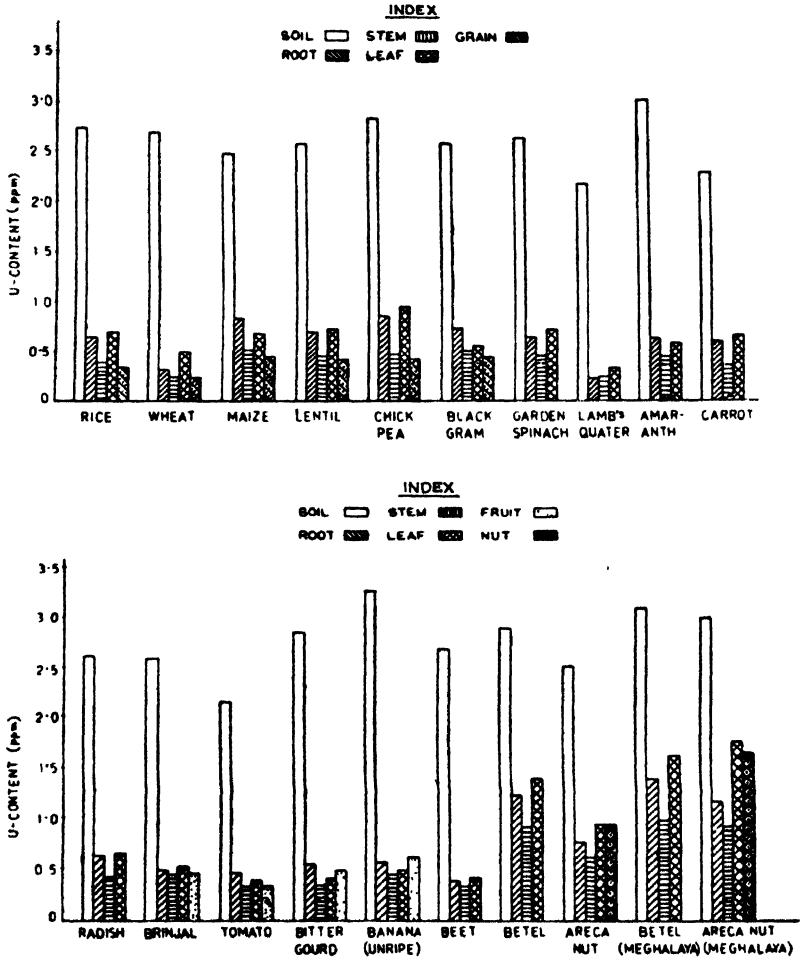

Figure 1. Bar diagrams showing U-contents of various samples.

Table I. Uranium contents of the soils and various parts of the plants.

Sl. No.	Items studied	Soil/parts studied	No. of tracks counted	U-concentration in ppm
1.	Rice	*Soil	4210	2.72 ± 0.04
		Root	3564	0.64 ± 0.01
		Straw	2892	0.37 ± 0.006
		Leaf	3615	0.69 ± 0.01
		Grain	2913	0.34 ± 0.006
2.	Wheat	*Soil	3927	2.67 ± 0.04
		Root	2574	0.30 ± 0.005
		Straw	2217	0.23 ± 0.005
		Leaf	2973	0.49 ± 0.009
		Grain	2289	0.22 ± 0.004
3.	Maize	*Soil	3715	2.44 ± 0.04
		Root	2963	0.80 ± 0.01
		Straw	2658	0.48 ± 0.009
		Leaf	2458	0.65 ± 0.01
		Grain	2532	0.42 ± 0.008
4.	Lentil	*Soil	4539	2.55 ± 0.03
		Root	3123	0.67 ± 0.01
		Stem	3011	0.43 ± 0.007
		Leaf	3279	0.69 ± 0.01
		Grain	2998	0.39 ± 0.007
5.	Chick pea	*Soil	4572	2.81 ± 0.04
		Root	3413	0.82 ± 0.01
		Stem	2782	0.45 ± 0.008
		Leaf	3154	0.91 ± 0.01
		Grain	2835	0.39 ± 0.007
6.	Black gram	*Soil	4321	2.54 ± 0.03
		Root	2875	0.70 ± 0.01
		Stem	2634	0.48 ± 0.009
		Leaf	2791	0.53 ± 0.01
		Grain	2615	0.45 ± 0.008
7.	Garden spinach	*Soil	4435	2.61 ± 0.03
		Root	3379	0.63 ± 0.01
		Stem	3291	0.44 ± 0.007
		Leaf	3118	0.71 ± 0.01

Table 1. (Contd.)

Sl. No.	Items studied	Soil/parts studied	No. of tracks counted	U-concentration in ppm
8.	Lamb's quaters	*Soil	4117	2.13 ± 0.03
		Root	2018	0.22 ± 0.005
		Stem	2142	0.23 ± 0.005
		Leaf	2073	0.31 ± 0.006
9.	Amaranth	*Soil	3528	2.98 ± 0.05
		Root	2618	0.62 ± 0.01
		Stem	2481	0.44 ± 0.008
		Leaf	2455	0.57 ± 0.01
10.	Carrot	*Soil	4581	2.28 ± 0.03
		Root	2654	0.60 ± 0.01
		Stem	2463	0.34 ± 0.006
		Leaf	2339	0.66 ± 0.01
11.	Radish	*Soil	4275	2.63 ± 0.04
		Root	3417	0.64 ± 0.01
		Stem	3182	0.44 ± 0.001
		Leaf	3298	0.66 ± 0.01
12.	Brinjal	*Soil	3329	2.62 ± 0.04
		Root	2419	0.49 ± 0.01
		Stem	2523	0.43 ± 0.008
		Leaf	2473	0.52 ± 0.01
		Fruit	2513	0.46 ± 0.009
13.	Tomato	*Soil	3478	2.16 ± 0.03
		Root	2318	0.46 ± 0.009
		Stem	2234	0.33 ± 0.007
		Leaf	2354	0.39 ± 0.008
		Fruit	2415	0.34 ± 0.007
14.	Bitter gourd	*Soil	3877	2.87 ± 0.04
		Root	2645	0.54 ± 0.01
		Stem	2471	0.40 ± 0.008
		Leaf	2349	0.39 ± 0.008
		Fruit	2483	0.49 ± 0.009
15.	Banana (unripe)	*Soil	3589	3.27 ± 0.05
		Root	2642	0.56 ± 0.01
		Stem	2574	0.45 ± 0.008
		Leaf	2592	0.48 ± 0.009
		Fruit	2687	0.52 ± 0.01

Table 1. (Contd.)

Sl. No.	Items studied	Soil/parts studied	No. of tracks counted	U-concentration in ppm
16.	Beet	*Soil	3839	2.68 ± 0.04
		Root	2675	0.37 ± 0.007
		Stem	2513	0.33 ± 0.006
		Leaf	2563	0.41 ± 0.008
17.	Betel	*Soil	4713	2.90 ± 0.04
		Root	3794	1.23 ± 0.02
		Stem	3014	0.91 ± 0.01
		Leaf	3075	1.40 ± 0.02
18.	Areca nut	*Soil	4683	2.52 ± 0.03
		Root	2754	0.77 ± 0.01
		Stem	2831	0.62 ± 0.01
		Leaf	2551	0.94 ± 0.01
		Nut	2675	0.94 ± 0.01
19.	Betel (Meghalaya)	*Soil	5437	3.1 ± 0.04
		Root	3575	1.40 ± 0.02
		Stem	3617	0.99 ± 0.01
		Leaf	3683	1.63 ± 0.02
20.	Areca nut (Meghalaya)	*Soil	5214	3.06 ± 0.04
		Root	3013	1.18 ± 0.02
		Stem	3157	0.92 ± 0.01
		Leaf	2983	1.77 ± 0.03
		Nut	3159	1.66 ± 0.02

*Soils collected from the respective plant habitat.

The samples have been prepared following the standard procedure of nuclear etch technique. The tracks produced on lexan sheets are scanned with an optical microscope under a magnification of 640X. Each track on the lexan sheet indicates the presence of uranium. As such uranium content may be estimated using the formula :

$$C_w(\text{unknown}) = C_w(\text{standard}) \times \frac{d_{\text{unknown}}}{d_{\text{standard}}}$$

where C_w refers to U-concentration and d refers to track densities.

3. Results and discussion

The uranium contents of the soils and plant parts studied have been presented in Table 1 and Figure 1. The errors indicated in the Table 1 are statistical counting errors.

From the Table 1, it is observed that in general uranium contents in soils and plant parts vary from 0.22 ± 0.005 to 3.27 ± 0.05 ppm. The average uranium contents of soil samples are found to be 2.67 ppm ; roots 0.68 ppm ; stems 0.48 ppm ; leaves 0.72 ppm ; fruits 0.45 ppm and grains and nuts 0.60 ppm. In the soil samples collected from the respective plant habitat, uranium concentration is found to be higher than the plant organs in each case. This is not unexpected as plants collect trace elements mostly from the soil. However, in addition to root uptake, foliar deposition in another source by which plants collect their nutrients. It may be noted that during nuclear detonation the foliar deposition is very high (Eisenbud 1973). However, we have conducted our experiments in a normal environment, as such one would expect accumulation of uranium by foliar absorption to be less than the root uptake. Again, we do not find much variation in the distribution of uranium in different parts of the plant. This shows that after root uptake and foliar absorption this element translocated almost uniformly throughout the plant body. There seems to be no critical organ for accumulation of this element.

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