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Current Strontium-90 Level in Diet in United States

Knowledge of the concentration of strontium-90 in the diet permits calculation of the equilibrium level in the human skeleton (*1*). This report (*2*) describes measurements on approximately 100 food samples. Samples of the important calcium (and therefore strontium-90), sources—that is, milk, vegetables, cereals, and tap water—are included.

Each vegetable sample (Table 1) represents 10 packages (about 3 kg) of frozen food, which in turn represent a production run at a food plant. The cereals (Table 2) were 200-g aliquots of a dozen boxes of the most common varieties. Liquid milk samples (Table 3) came mainly from cows that had grazed on unplowed land. Meat, eggs, and fish were omitted because their contribution to the calcium intake is trivial and because the Sr^{90}/Ca ratio is not expected to exceed that in milk by more than a factor of 2.

The chemical and radiometric procedures have been described elsewhere (*3*). The over-all yield of strontium was monitored with a Sr^{85} tracer. A representative set of six frozen vegetables was prepared according to the directions on the package, and the liquid phase was analyzed separately. No appreciable Sr^{90} is removed in the preparation of the vegetables for human consumption.

The data on U.S. milk (Table 3) include those of the Health and Safety Laboratory of the AEC New York Operations Office (*4*), extrapolated to late 1957 where necessary. The variations in Sr^{90} concentration from one farm to the next are probably related to the available calcium content of the pasture and to the average root depth of its grass. Duplicate milk samples from two nearby farms in Virginia gave 1.9 and 1.9, and 8.1 and 7.1 μμc of Sr^{90} per gram of calcium (hereafter referred to as strontium units, SU), respectively. Variations up to a factor of 2 occur from a single distribution source (Bergen County, N.J.) over a period of a month, reflecting changes in relative quantities of milk from contributing farms in successive batches. Despite these short-time variations, the average monthly value for different parts of the country is quite uniform, giving an average concentration for the country of about 6 SU. In comparison, the average level of Sr^{90} in British milk would be 7 to 8 SU in late 1957, on the basis of an extrapolation of the 1956 data (*5*).

The vegetables and cereals (Tables 1 and 2) are representative of large-acreage production. Variations from one sample to another grown in the same general area probably reflect different soil conditions. No appreciable increase in Sr^{90} from mid-1956 to early 1957 is observable from the data, as is not wholly unexpected, since an increase in Sr^{90} in the total fallout was only about 20 percent during this period.

Geographical differences in the Sr^{90} concentration appear but do not exceed two times the mean. In the diet, however, these differences are averaged out because of the nature of commercial food distribution. Some differences appear among plant types—for example, asparagus is relatively low, but among the major calcium contributors (peas, beans, and cereals), the Sr^{90} level is rather uniform.

The U.S. population obtains 85 percent of its calcium from milk, 4 percent from cereals, and 5 percent from vegetables (*6, 7*). If the average concentration of Sr^{90} in these foods in the United States in late 1957 is assumed to be 6, 15, and 10 SU, respectively, the average diet contains about 6.5 SU. In an extreme case, a vegetarian might have double this value.

Monthly integrated tap-water samples in the New York City area now carry about 0.1 μμc of Sr^{90} per liter. If an average consumption of 1 liter of water and 1 g of calcium from food each day is assumed, the contribution of Sr^{90} from

Table 1. Strontium-90 in common vegetables from various locations, 1956–57.

Sample	Date	SU
Maine		
Peas	8/56	21.3
Western New York State		
Beans, cut green	8/56	20.2
Beans, cut green	9/56	18.4
Beans, cut green	9/56	8.6
Beans, wax	7/57	13.6
Beans, wax	8/57	11.3
Cauliflower	10/56	9.1
Corn	9/56	28.4
Spinach	6/57	1.8
Av.		13.9
Eastern Pennsylvania, New Jersey, Long Island		
Asparagus	6/56	1.2
Asparagus	5/57	1.1
Beans, cut green	12/56	4.6
Beans, cut green	9/56	8.0
Beans, lima	9/56	6.6
Cauliflower	fall/56	8.1
Peas	6/57	10.0
Potatoes, sweet	?/57	13.3
Potatoes, white	?/57	6.1
Squash	fall/56	11.5
Av.		7.3
Eastern Maryland, Delaware		
Asparagus	10/56	1.7
Beans, lima	?/56	2.9
Beans, lima	9/56	8.4
Broccoli	10/56	4.7
Broccoli	10/56	6.7
Broccoli	10/56	8.5
Corn	12/56	3.6
Peas	12/56	1.3
Av.		4.7
Tennessee		
Okra	7/57	18.0
Spinach	?	6.1
Spinach	4/57	1.2
Turnip greens	5/57	21.3
Turnip greens	2/56	7.8
Av.		10.9
Minnesota		
Corn	9/56	1.6
Peas	6/56	5.8
Av.		3.7
Washington, Idaho, Oregon		
Beans, lima	9/55	6.3
Broccoli	9/56	3.7
Corn	8/57	2.1
Peas	6/57	4.8
Peas	7/56	7.8
Peas	6/56	3.0
Potatoes	?/57	8.7
Squash	9/56	3.1
Squash	10/56	3.7
Av.		4.8
California		
Asparagus	4/57	1.8
Beans, lima	5/57	4.6
Beans, lima	9/55	10.0
Beans, lima	9/56	4.3
Broccoli	4/57	4.0
Brussels sprouts	10/56	12.0
Brussels sprouts	9/56	4.3
Brussels sprouts	12/56	2.5
Brussels sprouts	11/56	1.1
Cauliflower	10/56	28.5
Cauliflower	4/57	22.5
Spinach	3/57	13.9
Spinach	3/57	9.1
Spinach	3/57	9.5
Av.		8.5
Av. for all vegetable samples		9.4
Av. for peas, beans, corn, and potatoes		8.7

Table 2. Strontium-90 in common cereals from various locations, 1956–57.

Sample and location	Date	SU
Wheat (New York)	?/56	22.8
Wheat (Washington)	55/56	9.1
Bran (Michigan)	summer/57	8.6
Flour (Illinois)	7/56	6.7
Rice (Unknown)	?/56	4.0
Wheat (Unknown)	?/56	37.5
Oatmeal (Unknown)	?/56	5.7
Av. for all cereals		13.5

Table 3. Strontium-90 in milk from various locations, 1956-57. The numbers in parentheses in column 3 give the number of samples.

Location	Date	SU	
New Jersey (Bergen County)	9-10/57	Range	3.0-7.7
		Av.	5.5 (14)
New Jersey (other)	10/57	Av.	5.5 (4)
New York City (retail)*			5.5
New York State (Perry)*			4.5
Mohawk Valley	9-10/57	Av.	6.6 (4)
North Carolina	8/57	Av.	5.3 (4)
North Dakota (powdered)*			10.0
Mississippi (State College, powdered)*	?/56		6.5
Missouri (St. Louis, powdered)*			6.5
Oregon (Portland, powdered)*			7.0
Virginia (Rockingham County)	10/57	Av.	3.8 (4)
Wisconsin (Columbus, powdered)*			5.5
Av. for all 1957 milk			6.1

* Estimated from an analysis reported by Health and Safety Laboratory, New York Operations Office of the AEC (*4*), extrapolated to late 1957.

drinking water appears to be negligible. If rain water were consumed, this source would still only account for about 20 percent of the daily Sr^{90} intake.

It is concluded that the Sr^{90} content in the diet of an average U.S. citizen in 1957 was about 6.5 SU, corresponding to an equilibrium base level of 1.6 SU, since the discrimination factor between diet and base appears to be about 4 (*1, 5*). If the diet concentration remains constant for a decade, the equilibrium bone level of 1.6 SU would be approached by young children. New-born children would have about half of this value on account of fetal discrimination, and adults would reach only 20 to 30 percent of the equilibrium level, because of the slow rate of exchange of the calcium in bone.

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References and Notes

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