Meetings

Fallout, Food, and Man

"Radioactive fallout is one of the nagging irritations of the cold war, and one of the most terrifying aspects of the threat of hot war. The need to make rational distinctions among quantitatively different situations has brought together scientists from widely different disciplines in a common endeavor. It has also forced laymen to try to understand technical concepts and has forced scientists to recognize that each scientist is a layman outside his own field." This philosophy, as expressed by J. Z. Holland (U.S. Atomic Energy Commission), provided the foundation for a symposium entitled "Fallout, Food, and Man" presented before the Federation of American Societies for Experimental Biology in Atlantic City, on 20 April. The program was cosponsored by the American Institute of Nutrition and the National Dairy Council.

Holland went on to review the factors influencing the distribution and physical-chemical nature of fallout. He noted that the radionuclides formed during a nuclear detonation have different boiling points and thus may condense at different times. These volatility differences may account for the variations in composition between the larger "close-in" fallout particles from surface explosions and the finer particles which remain suspended in the atmosphere for a long time. The former are enriched with the less volatile nuclides while the latter contain higher percentages of the more volatile decay chains (mass number = 89, 90, 131, 137, and 140). Recent data suggest that the material distributed in the stratosphere (which predominates from air bursts) may have a mean residence time of as much as 5 to 20 years.

The high altitude small particles contain radionuclides which are soluble in water and in dilute acid. Thus their primary method of deposition is in rain, which accounts for about 80 percent of the fallout deposited on the earth's surface. The spring maximum of stratospheric fallout in the middle latitudes (for example, the United States) is due to late winter and spring mixing of the stratosphere with the troposphere, coupled with generally higher altitudes for spring storm currents. Rainstorms also are more frequent during this period.

Holland noted that radioiodine, because of its short half-life (8 days) does not exhibit the same distribution characteristics as the longer-lived nuclides. It appears principally in local "hot spots," usually accompanying rainfall. Accurate documentation of the factors influencing its distribution and precipitation remains for future study.

R. G. Menzel (U.S. Department of Agriculture) commented that plants are the major vector in the transfer of fallout contamination from the environment to man. Even nuclides which are not available for absorption by the plants may be retained externally and consumed by animals or man. However, an amount up to 80 percent may be washed off by rain or subsequent food processing.

He reported that with the exception of plants with extensive surface root systems, as in some strains of rice, the uptake from the soil of radionuclides such as cesium-137 and strontium-90 is greater at a depth of several inches (conventional plow depth) than on the surface or at lower levels below the root zone. To be absorbed by plant root or leaf tissues, radionuclides generally must be soluble in water or in dilute acids. Translocation from the leaf surface to other parts of the plant is greater in younger than in older plants and is greater for cesium than for strontium.

Menzel emphasized that strontium absorption parallels that of calcium. Those plants, or parts of plants, which are higher in calcium also tend to be higher in strontium (for example, content would be higher in legumes than in grasses and higher in leaves than in seeds). Increasing the exchangeable calcium in the soil decreases the percentage of calcium taken up, and concomitantly decreases the relative strontium uptake. Thus, liming of acid soils may reduce strontium uptake by 50 percent or more. Similarly, addition of potassium to the soil has decreased radiocesium uptake in some crops.

C. L. Comar (Cornell University) discussed the factors influencing the biological availability of radionuclides for animals and man. He noted that the body burden of Sr^{90} is governed primarily by the Sr^{90}:Ca ratio of the total diet coupled with the comparative body retention of these two radionuclides. As in plants, Sr^{90} absorption parallels that of calcium. However, both animals and man discriminate against the absorption of strontium in favor of calcium; this effect is less pronounced in young infants than in children and adults. Plant foods and dairy products are the main contributors of Sr^{90} to the human diet. However, dairy products generally contain a lower Sr^{90}:Ca ratio than do plant foods because the dairy cow always secretes into milk a lower proportion of the strontium than of the calcium consumed in her ration. From a practical standpoint, the greater the proportion of dietary calcium coming from dairy products as compared to plant foods, the lower will be the Sr^{90}:Ca ratio of the human diet and the lower the ratio found in bones.

Comar noted that supplementation of dairy rations with uncontaminated calcium might be capable of reducing Sr^{90} levels of milk by 50 to 75 percent; stable strontium is not useful for this purpose. Similar supplementation of human diets does not appear feasible because of the potential long-term adverse health effects of the high levels of calcium required.

With regard to iodine-131, Comar stated that its short half-life shows that its existence is of primary concern only within weeks after a nuclear explosion. Estimations of potential hazard are based upon the rapid uptake of I^{131} by the thyroid gland, particularly in children from 6 to 24 months of age. Iodine uptake by fetuses is much less; it is zero in the fetus younger than 12 weeks. The relative thyroid dose from a given intake also decreases with age over 2 years, being 10 to 20 times less for older children and adults. Fresh milk is the most important contributor of I^{131} to the human diet. When cattle are removed from contaminated pastures, the I^{131} levels in milk fall rapidly within a matter of days.

The distribution of radionuclides in foods was reviewed by M. Eisenbud (New York University Medical Center). He pointed out that about 20 percent of the total normal radiation dose received by man arises from approximately 2300 $\mu\mu c$ of potassium-40 ingested daily in food. In addition, about a half million people in the middle western section of the United States drink water which has a radium content more than ten times normal. Recent studies in Brazil have shown that foods grown in certain areas have radium and mesothorium contents 10 to 30 times normal.

Eisenbud presented data showing that the Sr^{90} content of foods increased between 1954 and 1959 and then declined during the temporary moratorium on weapons tests. The values have again increased progressively since the fall of 1961 and may be anticipated to increase further during the next year or two, even in the absence of further testing. American children receive about 50 percent of their Sr^{90} intake from milk, primarily because this food is a principal source of calcium. However, other foods, particularly vegetable crops, have higher Sr^{90}:Ca ratios. Short-lived Sr^{89} may be present in foods at levels 10 to 20 times greater than Sr^{90}, but Sr^{89} does not accumulate in food items.

Cesium-137 is distributed in all foods and parallels potassium distribution. Iodine-131 is found primarily in fresh milk because of the rapid processing of this product for consumption. Those dairy products and other foods requiring longer processing times contain almost no radioiodine.

The fact that theories of radiation damage have been radically modified in the past decade was emphasized by H. B. Jones (University of California, Berkeley). The threshold theory has been replaced by a realization that tissue damage is a function of the dose received, at least at the relatively large (compared to fallout) doses studied to date. At these levels, radiation can kill cells, cause mutations, induce cancer, and perhaps simulate aging. Extrapolation of these effects downward into fallout radiation levels gives estimates of changes in the human population which are too infrequent to separate from those resulting from natural radiation.

In the case of I^{131}, primary concern is given to the possibility of inducing thyroid cancer in infants and young children. Adequate data are lacking on this point. However, present estimates suggest that one roentgen of thyroid exposure may increase the risk of thyroid cancer in the range of 1 in 10,000 to 1 in a million. The sum of other causes of thyroid cancer is much greater, thus emphasizing the difficulty of documenting fallout effects. Similar calculations suggest that increments in bone cancer from radiostrontium will be comparably small. Jones stressed that with the growing knowledge and newer theories we must not neglect conscientious attempts to quantify the effects of fallout, and must be careful to weigh anticipated gain against potential risk. He estimated that if natural radiation decreases life expectancy by about one month, then present fallout radiation may reduce life expectancy by about 0.1 month. In contrast, the automobile (considering the maimed and the dead) may reduce average life span by as much as 2 to 3 years. Nevertheless, the results of increasing long-term exposure from continued testing may ultimately have to be reckoned with.

M. S. Read (National Dairy Council) discussed research directed towards developing countermeasures against radionuclides in food. He pointed out that good farming practices (for example, liming of soil, and so forth) decrease radionuclide uptake by plants. Similarly, normal food preparation and processing (such as washing, milling, necessary delay in transit) remove sizable portions of fallout contamination from foods. The animal, too, may be considered to be a "fallout filter," by depositing only about 25 percent of the ingested Sr^{90} in the carcass and about 10 percent in the milk.

Several methods for reducing food contamination are under study. Placing cattle on aged feed, in which I^{131} has been reduced through normal decay, was tried in two parts of the country during 1962 with limited success. However, data from individual farms suggest that reductions of I^{131} concentration may be achieved by this method. These studies have delineated many of the problems requiring solution before this technique can be applied on a large scale to the nation's milk supply. Read cited work directed toward removing Sr^{90} from fresh fluid milk. A pilot plant has been developed that is capable of removing over 90 percent of the Sr^{90} from 100 gallons of milk per hour. The method has not been scaled to commercial needs and the necessary equipment is not available for purchase by dairies. In addition, the nutritional and bacteriological safety of the treated product has not been evaluated.

He concluded that many investigations are in progress concerning countermeasures. However, no method is yet available for widespread or for individual use nor are countermeasures recommended by health officials at the present time.

In the lively discussion period following the symposium, another important point was emphasized. Populations living at high elevations have 2 to 4 times the normal background radiation observed at sea level. Similarly, several population groups have lived for generations in environments giving radiation doses upwards to 100 times those usually considered normal. No adverse effects of these radiation levels have been demonstrated.

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Biomedical Information

One of the major events at the 47th annual meeting of the Federation of American Societies for Experimental Biology at Atlantic City, was a symposium on biomedical information on 17 April 1963.

The session opened with a brief description of the general growth of the scientific information problem and some explicit information about the expansion of the area of Federation interest by Robert A. Harte, chairman of the session and executive officer of the American Society of Biological Chemists. This was followed by a statement of government responsibility presented by F. Ellis Kelsey, special assistant to the surgeon general of the U.S. Public Health Service. Kelsey's statement was based largely on the conclusions reached by the Surgeon General's Conference on Health Communications (November 1962) and on the results of subsequent thinking in the Public Health Service on the problems speci-