■ Food Irradiation: Controversy on Safety and Efficacy Continues

No other food processing technique has had such close and detailed testing as radicidation, treatment with low levels of ionizing radiation at doses of up to 5 kGy. However, controversy about the safety of the irradiation process remains. In November 1989, the state of New York banned the sale of irradiated foods for general consumption with the exception of spices and foods served in hospitals to AIDS patients. The results of over 40 years of testing clearly indicate that irradiation of food can play a significant role in the prevention of food spoilage and in the prevention of food-borne disease transmissions.

Scientific Research and Testing Results

According to Clyde A. Takeguchi, PhD, of the Food and Drug Administration (FDA), Division of Food and Color Additives, food irradiation has been fraught with controversy since its initial inception as a food processing technique. Of the 35 countries that have granted regulatory approval of irradiated foods, 21 of them, including the U.S., actually utilize the technique. Research indicates that food irradiation has three distinct practical applications:

- decontamination and disinfestation
- longer shelf and storage life
- pathogenic bacteria control.

Many scientists believe that negative public perception to "things nuclear or radioactive" is a decisive factor in the limited use of a technique, that in the opinion of many, is safe and poses no physiological or environmental threat.

In 1986, the FDA approved the irradiation of fruits, vegetables, pork products, grains, and spices (in doses of up to 1 kGy for fresh foods and up to 30 kGy for spices) to destroy insects, bacteria and other microorganisms and to retard spoilage. The FDA made its ruling based upon the available data from decades of research on the possible toxicologic and physiologic effects of this technique. In its ruling, the FDA also redefined safety in the context of food additives and processing treatments (Federal Register, 1986;51:13376–13377):

> "Safe or safety means that there is reasonable certainty in the minds of scientists that the substance is not harmful under the intended condition of use. . . . Safety may be determined by scientific procedures or by general recognition of safety. In determining safety, the following factors shall be considered: (1) The probable consumption of the substance and of any substance formed in or on food because of its use; (2) The cumulative effects of the substance in the diet, taking into consideration any chemically or pharmacologically related substance or substances in such diet; [and] (3) Safety factors, which in the opinion of experts qualified by scientific training and experience to evaluate the safety of food and food ingredients, are generally recognized as appropriate."

Opposition against food irradiation has run the gamut from charges of nutritional loss to occupational and environmental hazards. In its January 1989 issue, RadWaste News (Vol. 10, p.2) reported upon the activities of the Health and Energy Institute and other groups who petitioned the FDA for a hearing to provide evidence against food irradiation. According to Radwaste, the opposition, presented in the form of 245 letters, addressed only 53 specific comments. The FDA denied the request for a hearing (see Federal Register 1988;53:53176) due to a lack of substantive evidence.

In spite of the documentation of years of research, for many people, the question remains, are irradiated foods safe?

Irradiation Process

When foods are irradiated, only the gamma rays from cobalt-60, the preferred source, or cesium-127 are used. Machine-generated x-rays at a maximum energy of 5 megavolts or machine-generated electrons at a maximum energy of 10 megavolts are used (Fig. 1). The energies from these radiation sources are too low to induce radioactivity in the food. Opponents contend, however, that the radiolytic products (also known as unique radiolytic products or URPS) caused by the radiation process are harmful. Radiolytic products have been seen, however, in nonirradiated processed foods (e.g., normal cooking practices) and tests conducted on irradiated food and these resultant byproducts have failed to show that these substances are harmful.

Many foods such as fruit, grains, vegetables, meats, and seafood are imminently suited for irradiation processing, and some foods, such as milk and other dairy products are not (Table 1). Moreover, irradiation processing is applicable to commonly known processing techniques such as sterilization and pasteurization.

In radiation sterilization, for example, irradiation treatment destroys microorganisms that might grow in food, allowing the sterilized food to be stored for years in sealed containers at room temperature without the threat of spoilage. Whereas this type of processing is not suitable for meat, poultry, and certain types of fish and vegetables because it produces unwanted changes in flavor and taste, radiation pasteurization provides an alternative processing treatment. In the pasteurization process, irradiation at doses lower than those used in sterilization delays spoilage of fish and shellfish, reduces the number of microorganisms in spices, kills certain types of disease-causing bacteria and parasites, and extends the shelf-life of a variety of fruits by delaying mold growth.

There is no evidence to suggest that food irradiation produces mutant strains of microorganisms that could be harmful. Furthermore, study results indicate that microorganisms not destroyed in the irradiation process are injured, making them vulnerable to destruction by cold or heat. Polyploidy, chromosonal changes in living

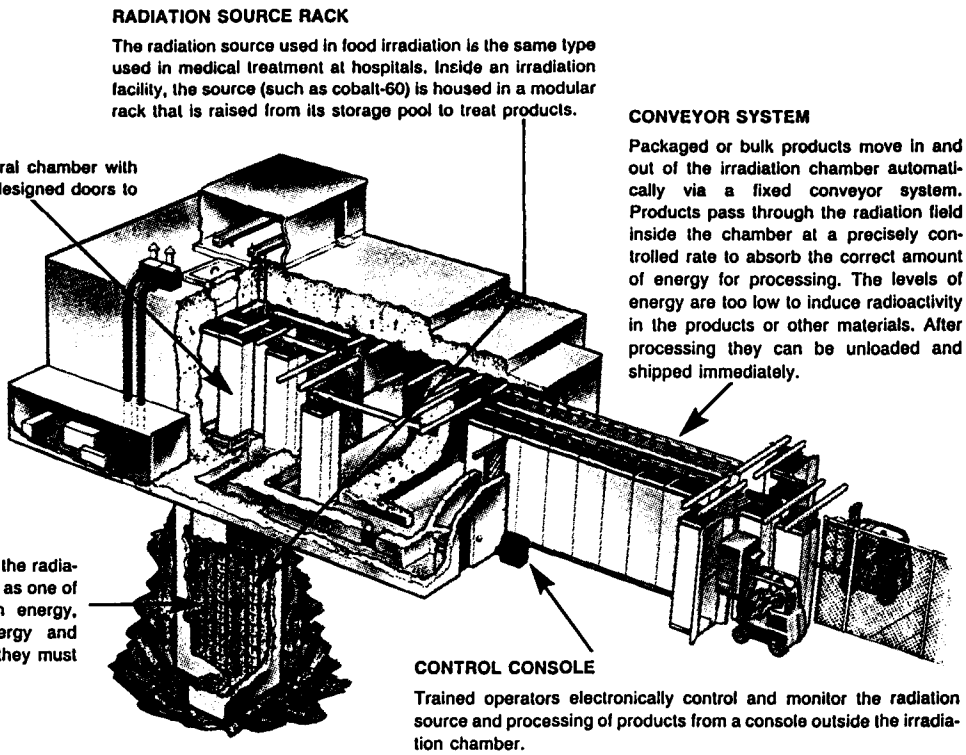

FIG. 1. An irradiation facility. These facilities must be licenses, regulated, and inspected by national safety and health authorities (NRC in the U.S.). Approximately 140 industrial gamma irradiators are operating worldwide to process food, medical products, and other goods. Many of them, like the one above, use radioactive sources of energy that emit gamma rays for processing products on a commercial scale. Other irradiator types, which are simpler in design and operation, are used to process smaller quantities, usually for research and training. There are approximately 400 irradiation facilities that use special machines (called accelerators or electron beam machines) that generate x-rays and electrons (Credit AECL, WHO). (Adapted with permission from *IAEA News Features,* December 1988, p.3.)

cells, have been observed, most notably in a series of papers by the Indian National Institute of Nutrition in which animals were fed freshly irradiated wheat as a major part of their diets, but the methodology and statistics in that work have been heavily criticized.

A report by the International Atomic Agency (IAEA) states that most foods are not noticeably affected by radiation processing. The extent of any changes is dependent upon the type of food being irradiated, the radiation dose, and other factors such as temperature during radiation processing.

Irradiation produces no significant changes in the nutritional quality of foods. According to the IAEA, vitamin loss can occur when high doses are used, but careful control in processing and storage conditions can offset this loss.

Of major concern to opponents is the possible increased risk of food poisoning in the event that tainted or spoiled food was inadvertently irradiated, resulting in a product in which spoilage could go undetected. Irradiation is effective only in destroying microorganisms in unspoiled food. It cannot reverse or correct food that has spoiled. Even in unprocessed food, spoilage is not necessarily an indication that the food is unsafe. The FDA has issued current good manufacturing practices (CGMP) to ensure appropriate handling, processing, packaging, and distribution of irradiated food products. Study results indicate that with diligent use of CGMPs irradiation would not increase the risk of food poisoning.

Since 1966, the FDA has required that irradiated food for wholesale or retail use bear a label stating that the food has been treated with ionizing radiation. Wholesale labels must state "treated with radiation, do not irradiate again" or "treated by irradiation, do not radiate again." Retail labels must bear a logo (Fig. 2) and either of the following statements: "treated with radiation" or treated by irradiation." Many food processors would like to eliminate the use of this labeling since informational labeling is not required for other types of processing. The FDA's requirement for this type of labeling is based not only the consumer's right to know that food has been irradiated (since there is no physical change in appearance or shape, detecting irradiated food from non-irradiated is difficult) but also to specify the purpose for the irradiation (pest control, mold prevention and etc.). The FDA's requirement, however, pertains only to food that has been directly irradiated and not to food that may contain irradiated ingredients.

Disease Control and Food Spoilage Prevention

The IAEA study reports that in the U.S. over 4 million people contract serious cases of food poisoning each year, and that thousands of these cases are fatal. Because certain bacteria are

TABLE 1. Applications of Food Irradiation

Type of Food	Radiation Dose in kGy	Effect of Treatment
Meat, poultry, fish, shellfish, some vegetables, baked goods, prepared foods	20–71	Sterilization. Treated product can be stored at room temperature without spoilage. Treated product is safe for hospital patients who require microbiologically sterile diets.
Spices and other seasonings	Up to maximum of 30	Reduces number of microorganisms and insects. Replaces chemicals for this purpose.
Meat, poultry, fish	0.1–10	Delays spoilage by reducing the number of microorganisms in the fresh, refrigerated product. Kills some types of food-poisoning bacteria and renders harmless disease-causing parasites (e.g. trichinae).
Strawberries and some other fruits	1–5	Extends shelf life by delaying mold growth.
Grain, fruit, vegetables, and other foods subject to insect infestation	0.1–2	Kills insects or prevents them from reproducing. Could partially replace post-harvest fumigants used for this purpose.
Bananas, avocados, mangos, papayas, guavas, and certain other non citrus fruits	1.0 maximum	Delays ripening.
Potatoes, onions, garlic, ginger	0.05–0.15	Inhibits sprouting.
Grain, dehydrated vegetables, other foods	Various doses	Desirable physical changes (e.g., reduced rehydration times).

Note: The FDA approves irradiation in low doses (up to 1 kGy) for disinfestation and maturation inhibition; higher doses are used internationally (up to 10 kGy). For low-dose irradiation for purposes other than those approved, data must be submitted which show that irradiation was effective for the stated purpose. Proposal for doses higher than 1 kGy (up to 3 kGy for poultry) are currently under review. Irradiation of meat and poultry will require FDA and USDA approval. (Table reprinted with permission from American Council on Science and Health).

destroyed in the irradiation process, irradiation can be useful in controlling disease caused by these organisms. A report by the American Council on Science and Health (ACSH) cites estimates from the USDA in which consumers will receive approximately $2 in benefits (reduced food spoilage and fewer incidences of illness) for each dollar spent on irradiating food. Irradiation of food seems more beneficial in view of FDA Division of Microbiology statistics: 5–17 billion dollars are lost yearly due to medical expenses and poorer job productivity because of food-borne disease illnesses.

According to Food and Agricultural Organization (FAO) estimates, approximately one-fourth of food production is lost after harvesting and in storage because of insects, bacteria, and rodents. In an era of heightened awareness of environmental and ecological issues, food irradiation may be a means of lessening the amount of fungicides, pesticides, and the insecticides used in food treatment.

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FIG. 2. Logo which must appear on irradiated food products for retail sale per FDA requirements.

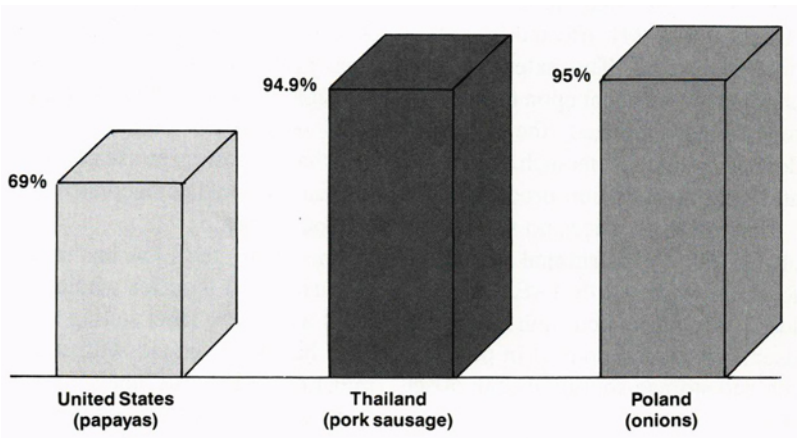

FIG. 3. Percentage of consumers who would purchase irradiated foods again. According to IAEA data, marketing tests in many countries indicate that consumers will buy foods labeled as being radiation processed. (Adapted with permission from *IAEA News Features,* December 1988, p. 10.)