Keeping Food Germ-Free

Growing concern over the safety of the U.S. food supply could lead to more facilities that will irradiate meat to kill bacteria, larva, and other carriers of diseases.

By Michael Valenti, Associate Editor

Sixteen Colorado diners became ill last year and 25 million pounds of ground beef were taken off the market—the largest such recall in U.S. history—all because of micro-organisms that made their way into the meat at one Nebraska processing facility. Such stories involving the E.coli bacteria, the culprit in Colorado, and other organic contaminants always raise fears among the public about food safety.

Several methods of destroying those organisms are available. One of the most effective and most controversial is irradiation, in which food is exposed to measured amounts of intense radiant energy to destroy any pathogens. While the technology was first put into regular use in the United States on bacon, wheat, wheat flour, and potatoes in the 1960s, the Food and Drug Administration (FDA) approved it for fresh and frozen red meats such as beef, lamb, and pork just last December. The agency's approval was made in response to a 1,300-page petition filed in 1994 by Isomedix Inc., an irradiation company in Whippany, N.J. According to John Masefield—founder, chairman, and CEO of Isomedix, and principal author of the petition—harmful microbial pathogens in food are estimated to cause as many as 9,000 deaths and 200 million to 250 million illnesses each year in the United States.

Fourteen Isomedix irradiation plants in the United States, Canada, and Puerto Rico currently sterilize disposable medical equipment and a broad range of consumer products, including baby-care products. "We will be able to conduct test work for the beef companies at our existing plants, and will be able to design dedicated beef-irradiation plants in the future.
based on this work,” said Grace Masefield, Isomedix’s director of market strategy development. These plants either would be dedicated to a single, large beef producer or would treat beef from smaller producers on a contract basis.

Any new facilities resulting from the FDA approval would most likely be based on designs from Isomedix or from the only two commercial food-irradiation companies currently operating in the United States: SteriGenics International in Tustin, Calif.; or Food Technology Service Inc. (FTSI) in Mulberry, Fla. However, despite the agency’s sanction of the process for meat, which should help contain outbreaks of virulent microorganisms such as E. coli O157:H7 and species of Salmonella, the construction of new food-irradiation plants will hinge on public acceptance of the practice.

Some consumer groups have expressed strong reservations about the process. According to Daniel Engeljohn, a food technologist and chief of the Standards Development Branch of the U.S. Department of Agriculture’s Food Safety and Inspection Service in Washington, D.C., the vocal opposition to food irradiation appears to be generated partly from people opposed to any aspect of the nuclear industry plus a lack of understanding of what irradiation actually is. “In fact,” he said, “food irradiation is a well-studied technology that has been more researched than any food-processing technique.”

Opposition to irradiation and the latest FDA approval also lies in concerns over food safety in general. “Consumers prefer to have no filth on meat than to have filth sterilized by irradiation,” said Michael Jacobson, executive director of the Center for Science in the Public Interest in Washington, D.C. And even though the FDA endorsed the process, the agency added that irradiation “is a complement to, not a replacement for, proper food-handling practices by producers, processors, and consumers.”

**DRIVING OUT CONTAMINANTS**

The push to improve food quality through irradiation began early this century, when researchers aimed newly discovered X-rays at foodstuffs to preserve them. In the 1950s, the availability of manmade isotopes such as cobalt-60, used to sterilize medical equipment, changed the course of food irradiation. Gamma rays emitted by the isotope were able to destroy pathogens in food as effectively as more-expensive technologies such as an electron accelerator. Since then, the technique has been applied to such items as poultry, fruits and vegetables, and spices.

In 1986, SteriGenics began irradiating dry-food ingredients such as pepper, onion powder, and dehydrated vegetable powder at facilities in Tustin; Schaumburg, Ill.; Rockaway, N.J.; and Salem, N.J. These plants irradiate approximately 50 million pounds of spices annually, according to Tom Mates, general manager of the Tustin facility. Founded in 1979 to sterilize single-use, disposable medical products such as syringes and gowns, the company now operates a total of 12 contract sterilization facilities in the United States and a joint venture in Taiwan.

The spices arrive at SteriGenics plant warehouses in bulk form in bags and drums, or sometimes in their final form in boxes. Workers affix dosimeters, such as those made by Far West Technology in Goleta, Calif., on the containers before loading them into metal containers or totes. The totes are loaded onto carriers that are suspended from an overhead monorail to move them into an irradiating treatment cell. The cell walls and ceiling are 6½-foot-thick concrete poured around steel rebar to ensure that no crack can penetrate the walls.

The totes are exposed to gamma rays with very short wavelengths, similar to ultraviolet light and microwaves, emitted from an array of cobalt-60 “pencils” installed on either side of an 8- by 16-foot stainless-steel rack. The pencils are actually stainless-steel tubes containing two zircon alloy tubes that encapsulate nickel-coated pellets of cobalt-60. When the pencils are not in use—during maintenance, for example—they are submerged in a 26-foot-deep pool of deionized water, more than twice the depth needed to protect maintenance workers when the array is submerged, and raised when irradiation recommences.

A U-shaped overhead conveyor in the cell guide the totes until they are exposed for a timed interval for the desired absorbed dosage of gamma radiation, a maximum of 30 kilograys for spices. (A gray, measuring the absorbed dose of ionizing radiation, is equal to 1 joule per kilogram.) The treated totes are returned to the warehouse on the other side of the conveyor dividing the loading and
unloading operations. The spice containers are removed from the totes and shipped to their customers.

SteriGenics retrofitted its Tustin plant in 1996 to treat low dose foods requiring less than 1 kilogram of radiation. “These are fresh vegetables, including avocado, onions, celery, bell peppers, and broccoli, that are sold either for retail sale or as ingredients for other products such as salsa,” Mates said. The shelf life of fresh produce irradiated at Tustin is extended by up to two weeks.

Palletized Loads

The year before SteriGenics began irradiating food, FTSI, the other American food irradiator, was formed because the Florida Citrus Commission sought an alternative to methyl bromide as a quarantine treatment for citrus. The agency was acting on an Environmental Protection Agency suggestion that methyl bromide, used to prevent the spread of fruit flies, would be banned (which will take place in 2001).

Accelerating Irradiation

The Iowa researchers load meat products onto carts attached to conveyor chains that transport the carts through the 9 3/4-foot-tall concrete walls of the irradiation area. The floor-mounted Circe 3 contains an electron gun comprising a cathode and anode that generate electrons, which are pulsed into an accelerating tube. At the same time, radio-frequency power is pulsed into the accelerating tube by a klystron, forming waves for the electrons to follow.

A series of alternating magnets in the tube accelerate the electrons to the high energy levels required for irradiation. When they reach the end of the tube, the electrons pass through a Glaser lens that focuses them into a beam. The beam is bent by a magnet to a 107-degree angle, so only the particles of the selected energy level are emitted. Those filtered electrons pass through a scanning magnet and sweep across the meat's surface, changing the DNA of microbes in the food and killing these pathogens.

Three different energy levels can be selected: 5 million, 7.5 million, and 10 million electron volts, which can penetrate 3/4, 1, and 1.5 inches on one side, respectively, or 1/4, 1/2, and 3/10 inches if both sides are irradiated. "We pick up some electrons when irradiating both sides, which is why the penetration is more than double," Olson said.

A multilayered safety system is a hallmark of the Ames irradiation facility, starting with the maze through which the carts are conveyed—three 90-degree turns that serve as a biological shield, preventing electrons or X-rays from ricocheting to the product-handling area. This and other safety devices are wired to the control panel and to the Circe 3.

"Thus, if one electric path fails, the other will trip the electron source and shut down the facility," Olson said.
gions. “Irradiation can also be used to pasteurize seafood,” Everett said.

FTSI's irradiator and safety control system were designed and built by MDS Nordion in Kanata, Ontario, a major supplier of cobalt-60 as well as a designer of medical-sterilization plants and research-irradiator equipment. “We became involved in FTSI to get a commercial food-irradiation facility going that would demonstrate not only the safety and efficacy of the technology but that consumers would buy clearly labeled irradiated foods,” said Frank Fraser, a mechanical engineer and vice president of market development at MDS.

The MDS engineers used their own controls and interlocks for the FTSI safety system, which also included radiation monitors, restricted openings, and a procedure to replace cobalt-60 pencils underwater with magnifying lenses and manipulators. Several hundred different conditions will automatically shut down the system in case of component failure or system inconsistency.

Unlike the process loops at other facilities, FTSI’s can irradiate large pallets of packaged foods. MDS engineers had to build a plant that would handle the heavier loads than their earlier systems could. According to Fraser, this involved scaling up the 48- by 24-inch conveyors used in facilities like the Canadian Irradiation Facility in Montreal to 48 by 42 inches to handle U.S. pallet sizes. “This involved testing monorails, bearings, wheels, and I-beams to build an overhead conveyor that could transport the 2-ton loads in a single carrier,” he said. “We also used hydraulic cushions to gently stop the larger loads, and built forklift clearances so the pallets could be loaded and unloaded from the carriers.”

These carriers are 18-foot-tall, 4-foot-wide, 4-foot-deep aluminum boxes holding a shelf at floor and midlevel. Forklift operators load a pallet on each shelf of the carrier. The carriers are transported from the warehouse into the 6 1/2-foot-thick concrete treatment cell via a pneumatic overhead monorail. Once inside, hydraulics move the carriers, primarily because greater locational accuracy of movement is required; this also reduces the number of cylinders needed to carry the heavy loads.

As in the SeriGenics process, the FTSI carriers follow a U-shaped trajectory in the treatment cell that exposes them to gamma rays from cobalt-60 pencils. The exposure time in the concrete cell and other process parameters is directed by Omron programmable logic controllers.

After being irradiated, the carriers return to the warehouse on the other side of an interior chain-link fence that separates the two halves of the irradiating process. The pallets are removed by forklift and placed on trucks for delivery. “Our intent is to expand irradiation to service other parts of the country,” Everett said. “The approval of using the technique to treat beef can only help.”

**IRRADIATION’S FUTURE**

According to Everett, the most likely scenario for plant construction in the future “is building dedicated food-irradiation plants either at or as near as possible to the point of transportation and distribution, after the final packaging and labeling is complete, to prevent the possibility of recontamination after irradiation.”

SeriGenics’ Mates agreed with the importance of location, especially because rising freight costs could exceed irradiation costs. (An increase in gasoline prices could also affect the economics of irradiation.) He noted that relatively few plants, each of which he estimated at $10 million to $12 million, would suffice. “For example, a well-built, well-located spice plant could treat up to 150 million pounds of product a year.”

“Food irradiation is a technology whose time has come, because food inspection and testing are revealing more incidents of foodborne disease,” MDS’s Fraser added. “Also, based on trade shows we attend, studies we conduct, and the experience of the commercial irradiators like FTSI, we were able to show that consumers are willing to buy irradiated food. The next step is convincing corporate officers that irradiated foods will sell.”