USDA Statement

A Focus on Food Irradiation

After the discovery of the X-ray and short wavelength, the technology of food irradiation was introduced. Many studies were performed during the first half of the 20th Century to determine its ability to provide more and safer foods to humanity worldwide.

Since the 1950s, many beneficial effects of ionizing radiation have been observed in addition to the potential to greatly reduce the incidence of foodborne diseases. Since these initial observations, there have been studies to challenge all the conceivable harms of the process.

Food irradiation is a food safety technology designed to greatly reduce disease-causing germs from food. It is the process of exposing food to high levels of radiant energy, similar to the technology used for years in the sterilization of medical and dental supplies.

Irradiation is constantly moving through the air, and it is the length of the wave that determines the affect of the irradiation. Microwaves, for example, are long wavelengths with lower energy levels, enough to move molecules resulting in the warming of food. The wavelengths used in food irradiation are shorter with higher levels of energy, enough to change atoms.

Irradiation penetrates into food, killing microorganisms without significant increases in the temperature of the food. With the process not affecting the temperature, it has also become known as “cold” pasteurization. It is similar to the process of pasteurizing milk.

The dosage levels are easily controllable to reduce the loss of food quality. The treatment of food with ionizing radiation can kill bacteria and parasites that would otherwise cause foodborne diseases. The process of irradiation only compliments proper food handling and storage. It does not replace it.

Currently irradiation is the only known method to eliminate E. coli O157:H7 bacteria in raw meat. Irradiation also significantly reduces levels of other pathogenic organisms including Cyclospora, Listeria, Salmonella, Campylobacter and the protozoan parasite Toxoplasma gondi on raw products.

Not only does the irradiation process inactivate the organisms, but it frequently extends the shelf life of food. For example, irradiated poultry still requires refrigeration, but it will remain safe for the consumer for a longer duration of time.

Government agencies and educational institutions are two of the many bodies with continuing research in the field of food irradiation. In a number of research projects, the United States Department of Agriculture (USDA)/Agricultural Research Service (ARS) are studying the varying levels of radiation and comparing different sources to determine D-values and effectiveness on meat and poultry products.

Different foodborne pathogens are being evaluated as well as different food compositions and their relationships to irradiation efficacy. ARS is also studying consumer safety and processing costs.

The USDA/ARS National Program 108 Food Safety Progress Reports are available on the FSRIO website. For more information on these research projects, please visit the following sections of the Agency's 2005 Annual Report:

- Improve Microbiological Safety and Shelf-Life of Food by Treatment with Ionizing Radiation
- Non-Thermal and Advanced Thermal Food Processing Intervention Technologies

Extensive studies have been performed by the World Health Organization (WHO), Food and Agricultural Organization (FAO), and the International Atomic Energy Agency (IAEA), to determine the safety and quality of irradiated foods. It has been determined that there is no harm in the food itself or risk to the consumers,

that the disease-causing germs are dramatically reduced or even possibly eliminated, and the food itself does not become radioactive.

Through the use of food irradiation, there may be some nutritional content changes, but no more so than with other processing methods such as cooking, canning, or heat pasteurization. In studies, proteins, carbohydrates, and fats were found to be stable at levels up to 10 kGy. Vitamins A, C, E, and B1 (thiamin) were affected at levels of 1 kGy, but no greater than with other commercial processes. There is little or no change to the physical characteristics of most foods.

Food Irradiation Research Areas:

- Radioactive safety for consumers
- Combining beneficial effects of irradiation and other ingredients to improve sensory cahracteristics.
- Affects of Vitamin E on meat quality including odor and color after irradiation
- Radiation sensitivity of foodborne pathogens with foods of varying starting temperatures
- Reducing processing costs
- Improving consumer acceptance

Food and Drug Administration (FDA) approved irradiation in the United States for:

- Wheat and Wheat Flour – first approval to rid plants of insects, 1963
- NASA sterilizes meat for astronauts in space, 1972
- Pork products- controlling trichinosis, 1985
- Spices, tea, fruits, vegetables, grains – eliminating insects, 1986
- Fresh and frozen poultry - controlling Salmonella, other bacteria, 1990
- Fresh and frozen red meats such as beef, lamb and pork - Pathogen control, 1997
- Fresh shell eggs, 2000
- Animal feed ingredients, including pet treats - reducing risk of Salmonella contamination, 2001

What can Irradiation do:

At Low Doses:

Delays ripening and sprouting in fruits and vegetables), and
Controls insects and parasites (an alternative to chemicals and fumigation)

At Medium Doses:

Extends shelf-life,
Reduces spoilage, and
Reduces pathogenic organisms

At High Doses:

Sterilization of meat, poultry,
seafood, prepared foods and
Disinfection of spices

Approved dosages for US:

- Spices and dry vegetable seasoning, decontaminates and controls insects and microorganisms - 30 kGy
- Dry or dehydrated enzyme preparations, controls insects and microorganisms - 10 kGy
- All foods, controls insects - 1 kGy
- Fresh foods, delays maturation - 1 kGy

- Poultry, controls disease-causing microorganisms - 3 kGy
- Red meat (such as beef, lamb and pork) controls spoilage and disease-causing microorganisms - 4.5 kGy (fresh), 7 kGy (frozen)

Irradiation Resources
Irradiation cannot be used with all food because it can change their acceptability and palatability, usually those with high fat contents. For example, higher fat dairy products can have undesirable flavor changes. Some fruits such as peaches and nectarines, may have tissue softening. Oysters and other raw shellfish can be irradiated, but the shelf life and quality decreases because the live oyster inside the shell is damaged or killed by the irradiation.

Currently in the United Sates, strawberries and other fruits in Florida are being irradiated. Tropical fruits from Hawaii's mainland are being irradiated as a replacement to the normal fumigation process. Beef, pork, poultry and many commercial spices are also being irradiated. Forty countries are permitting food irradiation, including: France, the Netherlands, Portugal, Israel, Thailand, Russia, China, and South Africa.

The USDA estimates that the American consumer will receive approximately $2 in benefits such as reduced spoilage and less illness for each $1 spent on food irradiation. The Food and Drug Administration (FDA) requires that all food that has been irradiated carry the international symbol of the radura, and the statement "Treated with radiation" or "Treated by Irradiation" on the packaging.

How Food Irradiation Works:
The short, high energy waves of radiant energy of the irradiation process transfers into the molecules of the microbe. This energy creates reactive chemicals that damage the cells DNA. This damage interferes with the cell replication and thus duplication and reproduction of the organism fails.

Depending on the size of the organism, the amount of DNA, and how quickly the organism can repair itself, the sensitivity to the irradiation varies. Larger organisms, such as insects and parasites are easily eliminated with irradiation because they have a greater amount of DNA that can be affected and damaged. Smaller organisms, such as viruses, are more resistant. Irradiation is measured in units called “Grays” (GY). The killing effect of irradiation on microbes is measured in D-values. One D-value is the amount needed to kill 90 percent of that organism.

Applications of Food Irradiation:

Food irradiation is applied to food products for different purposes, including:

- **Controlling foodborne pathogens** – Irradiation is currently used to eliminate pathogens that cause foodborne illnesses, but this process does not protect the food from being recontaminated, and consumers should handle the food in the same manner as non-irradiated products by being aware of storage and handling, refrigeration and cooking time and temperatures, and cross contamination.
- **Preservation**– Irradiation can destroy or inactivate the organisms that cause spoilage and decomposition, thereby extending the shelf-life of the food. There are some advantages to irradiation for the purpose of preservation. Unlike canning, the food does not undergo a lot of heat, so the food is much closer to its original fresh state. There is no additional liquid required and there is little loss of its own liquid since the temperature does not rise. Therefore the flavor, texture and color remain very much like the original food.
- **Sterilization** – As with canned and other heat sterilized foods, the product can be stored for years at room temperature. This is helpful with military and space flights. It also can be beneficial to immune-compromised patients, and hospitals.
- **Controlling sprouting, ripening, and insect damage** – Irradiation is an alternative to chemicals. It can be used with tropical fruits, potatoes, grains, etc. There is no residue left on the food.

Regulators of Food Irradiation:
Food irradiation in the United States is primarily regulated by the FDA since it is considered a food additive. Other federal agencies that regulate aspects of food irradiation include:

- United States Department of Agriculture (USDA) - meat and poultry products
- Nuclear Regulatory Commision (NRC) - safety of the processing facility
- Department of Transportation (DOT) - safe transport of the radioactive sources

Each new food is approved separately with a guideline specifying a maximum dosage. Packaging materials containing the food processed by irradiation must also undergo approval.

Irradiation Technologies:

Currently three different technologies exist for the process of irradiating food products, including:

- **The first technology:** Use of radiation given off by a radioactive substance, such as Cobalt 60 or Cesuim 137. These particular substances give off photons that produce gamma rays. They do not release neutrons, thus the food does not become radioactive. The photons can penetrate up to several feet. This is the same technology that has been routinely used to sterilize dental and medical supplies. The photons are constantly released. When the substance is not in use, it is submerged in a pool of water that absorbs the photons safely and completely.
- **Electron Beam technology:** No radioactive substance is involved. Electrons are “shot from a gun” toward the substance. Shielding is needed to protect workers from the released electrons. This technology is limited since the electrons can only penetrate up to a little over an inch. The food must be very thin.
- **X-Ray technology:** This is the newest technology and is still being developed. A beam of electrons are directed onto a thin plate of gold or other metal producing a stream of X-rays much stronger than X-ray machines found in hospitals. Like the Cobalt technology, this technology can pass through thick foods, but like the electron beam technology requires protection for the users. A limited number of these machines have been built.

Public Interest:

Food irradiation is currently encountering public opposition because many organizations feel there is a danger to the environment and consumer. These concerns include the potential that the food itself may become radioactive, loose its nutritional value, long term health risks associated with eating the processed food, and environmental risks at the processing facilities.

There is controversy over the production of small amounts of substances called radiolytic products. There is debate over whether the levels produced are harmful and to what degree or risk is produced. There is no debate, however, that they are produced when food is irradiated. The public concern also looks ahead into the industry's use of irradiation as a fallback to sterilize "dirty" food.

Currently, 40 countries and a large number of government agencies and medical organizations are advocates of food irradiation as a safe and effective method to reduce the risk of foodborne illness. As identified, research has provided results discounting many of these misconceptions. Ongoing research continues to identify and improve the effectiveness of the irradiation process with the use of other ingredients and established food processes to improve costs, palatability and safety.

Agencies, such as the CDC, feel that consumer confidence will depend on making food clean first, and then the use of irradiation or pasteurization will make it safe. Food irradiation is a logical next step to reducing the burden of foodborne disease in the United States.

Organizations Supporting Food Irradiation:
American Dietetic Association
American Council on Science and Health
American Feed Industry Association
American Farm Bureau Federation
American Health Association
American Meat Institute
American Medical Association

American Veterinary Medical Association
Apple Processors Association
Chocolate Manufacturers Association
Council for Agricultural Science and Technology
Florida Fruit and Vegetable Association
Food and Drug Administration
Food Distributors International
Grocery Manufacturers of America
Health Physics Society
International Atomic Energy Agency
International Food Information Council
Institute of Food Technologists
Miller's National Federation
National Cattleman's Beef Association
National Confectioners' Association
National Fisheries Institute
National Food Processors Association
National Meat Association
National Pork Producers Council
National Turkey Federation
New England Journal of Medicine
Produce Marketing Association
United Egg Producers
United Fresh Fruit and Vegetable Association
United Nations Food and Agriculture
United States Department of Agriculture
U.S. Chamber of Commerce
Western Growers Association
World Health Organization

Organizations Opposing Food Irradiation:

Center for Food Safety
Sunshine Coast Environment Council
Lenape Nation
Organic Consumers Association
Public Citizen
Stop Food Irradiation Alliance

Resources:

1. Catch the Wave: Food Irradiation is here
   International Consultative Group on Food Irradiation
2. Food Irradiation: A Safe Measure
   (pdf format)
   FDA with Contributions from: USDA, HHS, American Meat Institute
3. Food Irradiation Information
   Iowa State University Extension
4. Food Safety, Irradiation
   Center for Infectious Disease Research and Policy
5. Frequently Asked Questions about Food Irradiation
   (pdf format)
   CDC/Minnesota Department of Agriculture, FDA, Minnesota Department of Health, and Minnesota Beef Council
6. Get the Facts about Food Irradiation
   CDC/Georgia Beef Board
7. Irradiation: A Safe Measure for Safer Food
   USDA & FDA
8. Irradiation—An Overview of a Safe Alternative to Fumigation
   USDA/ARS
9. Irradiation of Animal Feed (Talk Paper)
   FDA
10. Irradiation of Meat and Meat Products Review of Risk Analysis Issues
    USDA/FSIS

11. USDA Approves Irradiation of Meat to Help Improve Food Safety (News Release)
    USDA & FDA

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