# Food Irradiation:

# A Global Food Safety Tool

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Food is one of the most important necessities in life. Fortunately, many advanced and several developing countries have abundant supplies of fresh, safe and nutritious foods. Yet, despite the many precautions and processes in place to ensure a safe food supply, microbial contamination is still a concern, even in advanced countries. There are a number of food processing tools available that provide additional protection for the foods we consume. One very promising tool is food irradiation, which is a process of imparting ionizing energy to food to kill microorganisms. Sometimes it is referred to as “electronic pasteurization” where electricity is used or as “cold pasteurization” as an insignificant amount of heat occurs in the treated food. Just like traditional heat pasteurization of milk, food irradiation can enhance the safety of foods such as meat, chicken, seafood, and spices, which cannot be pasteurized by heat without changing their nature to a cooked, rather than a raw form. It is not a substitute for safe food handling and good manufacturing practices by processors, retailers, and consumers alike, since bacteria could be reintroduced later.

## What is Food Irradiation?

Food irradiation is the process of exposing food to an ionizing energy to kill harmful bacteria and other organisms, and extend shelf-life. It is a safe process and has been approved by some 50 countries worldwide and applied commercially in the USA, Japan, and several European countries for many years. Approved irradiated foods include fruits, vegetables, meat, poultry, fish and seafood, roots and tubers, cereals, legumes, spices and dried vegetable seasonings.

## How Does Food Irradiation Work?

When food is irradiated, it passes through an enclosed irradiation chamber where it is exposed to ionizing energy. This can be in the form of gamma rays from specific radioisotope sources, or x-rays or electron beams from machine-made sources. All three types of ionizing energy have the same ability to inactivate spoilage and disease-causing microorganisms without causing harmful changes to the food. In all instances food remains uncooked and free of any residue.

Only certain ionizing energy sources can be used for food irradiation. Permitted gamma sources are the isotopes cobalt-60 or cesium-137. Cobalt-60 is used in food irradiation because it ís widely available. Gamma rays are a form of electromagnetic energy, just like radio waves, microwaves,

Irradiation can help meat, poultry and seafood keep longer by reducing spoilage-causing microbes.

X-rays and even light. They have the ability to penetrate well into a food. Machine-generated X-rays have similar properties. More recently, electron beams (e-beams) have become available as a source of ionizing energy in the USA and other countries. Like X-rays, e-beams are machine-generated using ordinary electricity and can be powered on and off at the touch of a switch. E-beams offer extremely rapid and cost-effective processing, but in some cases sacrifice penetration depth depending on product density. Treatment of food using either X-rays or electron beams are occasionally referred to as "electronic pasteurization" or "electronic irradiation" methods because they are derived from electricity.

Regardless of the source of ionizing energy, the food is treated by exposing it to the energy source for a precise time period. In the case of e-beam, food is irradiated in just a few seconds, while it takes gamma and X-rays considerably longer. The food is never in contact with the energy source; the ionizing energy merely penetrates into the food but does not stay in the food. It takes very little energy to destroy harmful bacteria. At these levels there is no significant increase in temperature or change in composition. Irradiation does not make food radioactive nor does it leave any residues. The levels of ionizing energy used to treat foods for pathogen reduction or disinfestation are measured in kiloGrays (kGy). A low-to-medium dose of below 1-10 kGy is usually sufficient to render a product safe from harmful bacteria or insects such as fruit flies, while causing little or no effects on product quality or nutrition.

## What Are the Benefits?

The most significant public health benefit of food irradiation is that it stops the spread of foodborne disease. It greatly reduces or eliminates the number of disease-causing bacteria and other harmful organisms that threaten us and our food supply. Many of these organisms, including *Salmonella*, *Escherichia coli* O157:H7 (E. coli), *Staphyloccoccus aureus* (Staph), *Listeria monocytogenes*, *Campylobacter jejuni* and *Toxoplasma gondii* have caused many outbreaks of foodborne illness. When food is irradiated, the penetrating energy breaks down the DNA molecules of the harmful organisms. The food is left virtually unchanged, except that it is much safer because the number of harmful organisms is greatly reduced or eliminated. An added advantage is that food can be irradiated in its final packaging – fresh or frozen, which prevents the possibility of contamination in the distribution system, at the store, or even in the home, prior to the package being opened.

Although reduction of disease-causing bacteria is of greatest importance to public health and safety, there are other significant benefits of food irradiation. Irradiation can also help keep meat, poultry and seafood fresh longer by reducing the level of spoilage-causing microbes. It also allows consumers to keep certain fruits and vegetables fresh longer. For example, irradiated strawberries stay unspoiled for up to three weeks, versus three to five days for berries that are untreated. For many developing countries, food spoilage is an ever-present and costly reality, often causing produce spoilage rates in excess of 40 percent. In these countries, irradiation stands to benefit millions by helping more nutritious fruits and vegetables reach consumers. When grains and spices, fresh and dried fruits, legumes and condiments are irradiated, the process eliminates any insects that might be present and can replace the use of chemical fumigants, which could leave residues or harm the environment. For example, irradiation is used as an alternative to chemical fumigation or vapor heat processes for treating fruits from Hawaii to meet quarantine requirements on the US mainland. It also has a potential to meet quarantine requirements for international trade in fresh fruits and vegetables in countries in other regions.

It is important to note that toxins, viruses or bacterial spores are resistant to irradiation. Therefore, it is essential that irradiation be used in conjunction with all other established safe food handling and good manufacturing practices.

## How Widespread is Foodborne Illness?

Foodborne illness outbreaks have been associated with almost every food commodity: dairy products, eggs, meats, seafood, poultry and fruits and vegetables. Outbreaks can occur because of cross contact during food handling, processing and home preparation. A growing concern to many health officials is the emergence of new strains of bacteria and other organisms. One example is *E. coli* O157: H7. Unknown 25 years ago, this virulent bacterium can be life-threatening to children, older people and those with compromised immune systems.

To better understand the impact of foodborne illness on health in the United States for example, the Centers for Disease Control and Prevention (CDC) estimates foodborne illness causes approximately 76 million illnesses; 325,000 hospitalizations and 5,000 deaths each year or approximately 100 deaths per week. Pathogens (disease-causing organisms) such as *Salmonella*, *Listeria* and *Toxoplasma* are responsible for 1,500 deaths annually.

Food irradiation can be a boon for consumers and have a phenomenal impact on the safety and growth of the global food supply. Internationally renowned organizations including the World Health Organization (WHO), the American Medical Association (AMA), and The American Dietetic Association (ADA) have embraced this technology for the food safety benefits it provides. In fact, the first Golden Rule for Food Safety of the WHO states among other things "always buy pasteurized as opposed to raw milk, and if you have a choice, select fresh or frozen meat treated by ionizing radiation."

European countries such as Belgium, France and the Netherlands have irradiated frozen shrimp, frog legs and spices to ensure microbiological safety on a commercial basis for the past two decades. Fermented pork sausages, usually consumed raw in Thailand, have been irradiated to control *Salmonella* and other harmful organisms and have been marketed widely since 1986. Ground beef has been commercially irradiated to inactivate deadly *E. coli* O157:H7 in the United States since mid-2000 with products available in several supermarkets and now starting within the foodservice industry. Over 90,000 metric tons of spices and dried vegetable seasonings were irradiated for commercial purposes in some 20 countries in 2000. These are just some examples of the benefits of irradiation to ensure the microbial safety of food.

## What Are Consumers' Reactions?

Research has shown that consumers are enthusiastic about purchasing clearly labeled irradiated food for themselves and their families, including children, after they have been informed of the safety and benefits of the technology. Consumers also indicated that, for irradiated foods, safety and taste were more important than price, and they believed that eliminating harmful bacteria was a more valuable benefit than extended shelf-life. Market tests conducted in the past decade, have indicated that consumers were willing to purchase irradiated foods when they understood the benefits. Nevertheless, more education is necessary for consumers to become more familiar with the process and its benefits.

Some segments of the population, such as astronauts, hospital patients and immuno-compromised individuals have been taking advantage of the safety benefits of irradiated foods to protect them from potential foodborne disease. Populations in Belgium, China, France, South Africa and Thailand have had the choice for safe food through irradiation for the past two decades. In countries where irradiated foods are banned or restricted, consumers are given little if any choice. Starting from mid-2000, commercial scale irradiation of meat and meat products was launched in the USA with great success. Consumers learned to accept quickly the safety benefits which irradiated food brought to them. The number of supermarkets, which put irradiated food on sale increased exponentially from 84 supermarkets in May 2000 to some 2000 a year later and several tons of irradiated beef were sold. A recent statement from Huisken Meats of Minnesota, which pioneered the marketing of irradiated beef, reported, "Demand for irradiated beef has been strong from the beginning (May 2000). In 1999, the company projected 2 million lbs of irradiated beef patties would sell in its second and third quarters. Instead, they sold that amount in five weeks.

## How Is Food Irradiation Regulated?

Over the past 40 years, several national food control authorities have extensively studied this food process under a variety of conditions and found it to be safe and effective. Worldwide, some 170 industrial cobalt-60 irradiators and hundreds of electron accelerators have been processing a variety of goods, including industrial, medical and food products. In the United States, the Food and Drug Administration (FDA), the Department of Agriculture (USDA), Department of Defense (DOD), and National Aeronautics and Space Administration (NASA) are among the governmental organizations to either approve or establish guidelines for food irradiation.

Several of these organizations have studied the irradiation process to determine any possible risks to public safety. These tests

and others conducted by independent researchers in the field of industrial radioactive materials transportation and plant worker safety have consistently concluded that employees at food irradiation plants as well as citizens in nearby communities face a very minimal risk of radioactive contamination. In fact, the safety record of this technology is excellent. Irradiation is environmentally friendly since it reduces the need for harmful pesticides in produce disinfestation.

It is easy for consumers to determine if a food has been irradiated. Regulations require that irradiated food be labeled as such and often it may be accompanied by an international food irradiation logo. The current labeling includes statements such as “treated with radiation” or “treated by irradiation.” In some countries positive labeling for consumer information is acceptable, such as “Irradiated for safety” or “Treated by irradiation to reduce harmful bacteria”.

Consumers consistently rated irradiated fruit as equal to or better than that which was not irradiated in terms of appearance, freshness and taste.

## Is Food Irradiation Safe?

Yes. Food has been irradiated in several countries for many years resulting in products that are safer for consumption than the untreated original foods. According to the WHO, the renowned global authority on public health, "Food irradiation is a thoroughly tested process and when established guidelines and procedures are followed, it can help ensure a safer and more plentiful food supply."

A number of compounds are formed when food is irradiated, just as there are when food is cooked or exposed to other processing methods. However, based on hundreds of scientific tests, there is broad agreement among scientists and health agencies that these compounds are not a human health issue. In fact, more chemical changes occur when toasting bread or barbecuing steak than when irradiating food.

Food irradiation provides an added layer of protection to food without significant changes to taste, nutritional value, color or texture. Since irradiation does not substantially raise the temperature of food or "cook it," taste and nutrient losses are small and considerably less than other methods of preservation, such as canning, drying or heat pasteurization. Carbohydrates, fats and proteins are the main components of food, and a wide body of research has shown that these nutrients do not change significantly during irradiation. Some vitamins, most notably the B vitamins, have some sensitivity to irradiation, but processors can minimize nutrient losses by irradiating food in an oxygen-free environment or a cold or frozen state.

## Is Irradiation the Answer for Food Safety?

While food irradiation is an important process that promotes food safety, it is not a substitute for safe food handling by processors, retailers and consumers. Although food irradiation may kill many organisms in food that is already spoiled, it cannot suppress odors or other signs of spoilage, and thus cannot be used as a means to "hide" or "cover up" spoiled food. Bacteria and other microorganisms that produce bad odors or discoloration will still exist as a warning sign to consumers that a food has spoiled, even after the food has been irradiated. In addition, food irradiation goes hand-in-hand with modern Hazard Analysis and Critical Control Points (HACCP), a preventative food safety management system that is mandated in meat, poultry and seafood processing plants in many countries.

Consumers must practice safe food handling techniques, whether the food is irradiated or not. It is still possible for bacteria to multiply in irradiated food if it has not been refrigerated properly or if care was not taken to avoid cross contamination with harmful bacteria from other sources.

### For Further Reading


*Consumer Attitudes Toward Food Irradiation*, July 1998. Conducted by Axiom Research Company for the International Food Information Council (IFIC). http://ific.org

"A Review of the Safety of Cold Pasteurization." By Lester M. Crawford and Eric H. Ruff, Food Control, Vol. 7, No. 2, pp. 87-97, 1996.

*Consumer Attitudes and Market Response to Irradiated Food*, 1999; *Safety of Poultry Meat From Farm to Table*, 1999; *Facts about Food Irradiation*, 1991. International Consultative Group on Food Irradiation (ICGFI). http://www.iaea.org/icgfi

"Food-Related Illness and Death in the United States," Sept/Oct 2000. By Paul S. Mead, et al. *Emerging Infectious Diseases*, Vol. 5, No. 5. http://www.cdc.gov/ncidod/eid/vol5no5/mead.htm

"U. S. Regulatory Requirements for Irradiating Foods," May 1999. By George H. Pauli, U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition, Office of Premarket Approval. http://www.cfsan.fda.gov/~dms/opa-rdtk.html

"Food Irradiation – Position of ADA." By Olivia Bennett Wood and Christine M. Bruhn. *Journal of the American Dietetic Association*, Vol. 100, No. 2, pp. 246-253, Feb 2000. http://www.eatright.org/adap0200.html

When preparing meals for yourself or your family, it is important to remember these four simple steps to keep your food safe from harmful bacteria. It's as simple as 1-2-3-4.

1. Clean: Wash hands and surfaces often
2. Separate: Don't allow cross contamination between raw and cooked foods
3. Cook: Cook to proper temperatures
4. Chill: Refrigerate promptly

These are four powerful tools to help make the meals from your kitchen as safe as possible. The potential for food irradiation to reduce the incidence of worldwide food-borne illness is enormous. An extensive review of scientific studies on food safety indicates that irradiation is a safe and effective solution to food contamination by harmful bacteria and other microorganisms. It will bring public health benefits to solid foods, e.g. meat, poultry, seafood, spices, fruits and vegetables, in the same manner as pasteurization has effectively done for milk and fruit juices, in the past century.

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