Background Information

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One of the newest and most controversial methods available to both eliminate *E. coli* contamination and prevent food spoilage is the use of irradiation, sometimes called electronic pasteurization. The following information was excerpted from the CDC website www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm
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Like pasteurization of milk, and pressure cooking of canned foods, treating food with ionizing radiation can kill bacteria and parasites that would otherwise cause foodborne disease. The food that NASA astronauts eat has always been sterilized by irradiation to avoid getting foodborne illness in space. The effects of irradiation on the food and on animals and people eating irradiated food have been studied extensively. These studies show clearly that when irradiation is used as approved on foods:

- disease-causing germs are reduced or eliminated
- the food does not become radioactive
- dangerous substances do not appear in the foods
- the nutritional value of the food is essentially unchanged

Treating raw meat and poultry with irradiation at the slaughter plant could eliminate bacteria commonly found on raw meat and raw poultry, such as *E. coli* O157:H7, *Salmonella*, and *Campylobacter*. These organisms currently cause millions of infections and thousands of hospitalizations in the United States every year. Irradiating prepared ready-to-eat meats like hot dogs and deli meats, could eliminate the risk of *Listeria* from such foods. Irradiation could also eliminate parasites like *Cyclospora* and bacteria like *Shigella* and *Salmonella* from fresh produce.
The potential benefit is also great for those dry foods that might be stored for long times and transported over great distances, such as spices and grains. Animal feeds are often contaminated with bacteria like *Salmonella*. Irradiation of animal feeds could prevent the spread of *Salmonella* and other pathogens to livestock through feeds.

Three different irradiation technologies exist to irradiate food, which use three different kinds of rays: gamma rays, electron beams and x-rays. The first technology uses the radiation given off by a radioactive substance. This can be either a radioactive form of the element cobalt (Cobalt 60) or of the element cesium (Cesium 137). These substances give off high-energy photons, called gamma rays, which can penetrate foods to a depth of several feet. These particular substances do not give off neutrons, which means they do not make anything around them radioactive. This technology has been used routinely for more than thirty years to sterilize medical, dental and household products, and it is also used for radiation treatment of cancer. Radioactive substances emit gamma rays all the time. When not in use, the radioactive "source" is stored down in a pool of water, which absorbs the radiation harmlessly and completely. To irradiate food or some other product,

the source is pulled up out of the water into a chamber with massive concrete walls that keep any rays from escaping. Medical products or foods to be irradiated are brought into the chamber, and are exposed to the rays for a defined period of time. After it is used, the source is returned to the water tank.

Electron beams, or e-beams, are produced in a different way. The e-beam is a stream of high-energy electrons, propelled out of an electron gun. This electron gun apparatus is a larger version of the device in the back of a TV tube that propels electrons into the TV screen at the front of the tube, making it light up. This electron beam generator can be simply switched on or off. No radioactivity is involved. Some shielding is necessary to protect workers from the electron beam, but not the massive concrete walls required to stop gamma rays. The electrons can penetrate food only to a depth of three centimeters, or a little over an inch, so the food to be treated must be no thicker than that to be treated all the way through. Two opposing beams can treat food that is twice as thick. E-beam medical sterilizers have been in use for at least fifteen years.

The newest technology is X-ray irradiation. This is an outgrowth of e-beam technology, and is still being developed. The X-ray machine is a more powerful version of the machines used in many hospitals and dental offices to take X-ray pictures. To produce the X-rays, a beam of electrons is directed at a thin plate of gold or other metal, producing a stream of X-rays coming out the other side. Like cobalt gamma rays, X-rays can pass through thick foods, and require heavy shielding for safety. However, like e-beams, the machine can be switched on and off, and no radioactive substances are involved. Four commercial X-ray irradiation units have been built in the world since 1996.

The foods are not changed in nutritional value and they are not made dangerous as a result of the irradiation. The high-energy ray is absorbed as it passes through food, and gives up its energy. The food is slightly warmed. Some treated foods may taste slightly different, just as pasteurized milk tastes slightly different from unpasteurized milk. If the food still has living cells, (such as seeds, or shellfish, or potatoes) they will be damaged or killed just as microbes are. This can be a useful effect. For example, it can be used to prolong the shelf life of potatoes by keeping them from sprouting. The energy can induce a few other changes. At levels approved for use on foods, levels of the vitamin thiamine are slightly reduced. This reduction is not enough to result in vitamin deficiency. There are no other significant changes in the amino acid, fatty acid, or vitamin content of food. In fact, the changes induced by irradiation are so minimal that it is not easy to determine whether or not a food has been irradiated.

Irradiated foods need to be stored, handled and cooked in the same way as unirradiated foods. They could still become contaminated with germs during processing after irradiation, if the rules of basic food safety are not followed. Because the irradiated foods have fewer microbes of all sorts, including those that cause spoilage, they may have a longer shelf life before spoiling.

The safety of irradiated foods has been studied by feeding them to animals and to people. These extensive studies include animal feeding studies lasting for several generations in several different species, including mice, rats, and dogs. There is no evidence of adverse health effects in these well-controlled trials. In addition, NASA astronauts eat foods that have been irradiated to the point of sterilization (substantially higher levels of treatment than that approved for general use) when they fly in space. The World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC) and by the Assistant Secretary of Health, as well as by the U.S. Department of Agriculture (USDA) and the Food and Drug Administration (FDA) have endorsed the safety of irradiated foods.

When microbes present in the food are irradiated, the energy from the rays is transferred to the water and other molecules in the microbe. The energy creates transient reactive chemicals that damage the DNA in the microbe, causing defects in the genetic instructions. Unless it can repair this damage, the microbe will die when it grows and tries to duplicate itself. Disease-causing organisms differ in their sensitivity to irradiation, depending on the size of their DNA, the rate at which they can repair damaged DNA, and other factors. It matters if the food is frozen or fresh, as it takes a higher dose to kill microbes in frozen foods.

A variety of foods have been approved for irradiation in the United States, for several different purposes. For meats, separate approval is required both from the FDA and the USDA.

Approval Year	Food	Purpose
1963	Wheat flour	Control of mold
1964	White potatoes	Inhibit sprouting
1986	Pork	Kill Trichina parasites
1986	Fruit and vegetables	Insect control, increase shelf life
1986	Herbs and spices	Sterilization
1990 - FDA	Poultry	Bacterial pathogen reduction
1992 - USDA	Poultry	Bacterial pathogen reduction
1997 - FDA	Meat	Bacterial pathogen reduction
1999 - USDA (pending)	Meat	Bacterial pathogen reduction

A facility in Florida has been irradiating strawberries and other fruits on a limited basis, to prolong shelf life. On a trial basis, fresh tropical fruits from Hawaii have been irradiated before shipping them to the mainland, instead of fumigating them to eliminate the fruit fly pests that could spread to the mainland. Some spices for commercial use have been irradiated. In addition irradiation is widely used to sterilize a variety of medical and household products, from hip joint implants to band-aids and baby pacifiers.

Other technologies used to sterilize fruits, spices, and medical devices use toxic chemicals, such as ethylene oxide. Use of irradiation can reduce the use of these other hazardous substances.

This lab is a modification of a Simulation of Irradiation lab published by the Illinois Board of Education at www.isbe.state.il.us