Food Tech: New Tech

What You Need to Know!

Food irradiation **and** genetic engineering **are two "new" technologies used today to produce or enhance some of the foods in our food supply.**

FOOD IRRADIATION

Food irradiation is one method of treating food so it keeps longer or is safer to eat. It can be used to destroy insects in cereal grains or spices, inhibit sprouting of potatoes, and pasteurize meat so that it is free of harmful bacteria such as *Salmonella* or *E.coli* O157:H7. To date, the greatest use of irradiation has been in the medical field—medical and dental x-rays; detection and treatment of diseases; sterilization of medical equipment, medical devices, and pharmaceutical products; and production of sterilized food for special hospital diets.

The U.S. Food and Drug Administration (FDA) began approving the irradiation of specific food products nearly 40 years ago. In fact, irradiation has been used to treat food in the space program to prevent astronauts from getting sick on space flights. Today, however, public and private interests have come together to make ground beef and other food products safe, and irradiation pasteurized ground beef is now available in some markets in the United States.

What is Food Irradiation?

Radiation is a form of energy. We receive natural radiation from the sun. Radiation approved for use on food, however, is produced by machines or by decay of radioactive cobalt. **Irradiation** is the process of applying high energy radiation to a material, such as food, to sterilize, pasteurize or extend its shelf-life by killing microorganisms and insects. Sources of ionizing radiation that have been used include gamma rays, electron beams and x-rays. **Gamma rays** are produced by radioactive isotopes such as Cobalt-60. **Electron beams** are generated by a linear accelerator, which is powered by electricity. Electron beams and x-rays are "machine" sources of irradiation.

In food irradiation, the "dose" that food receives is not added to the food. The dose is the amount of radiation *absorbed* by the food during the time it is exposed to radiation. The dose is controlled by the intensity of the radiation and the length of time the food is exposed to the source. Irradiation is measured by the unit known as the kilogray (kGy).

A "low" dose of irradiation is up to 1 kGy and is designed to control insects in grains, inhibit sprouting in white potatoes, control *Trichinae* larvae in pork, and inhibit decay in fruits and vegetables. A "medium" dose is 1 to 10 kGy and can be used to control harmful bacteria in meat, poultry and fish, and also to delay mold growth on strawberries and other fruits. A "high" dose, greater than 10 kGy, is used to kill microorganisms and insects in spices, and to commercially sterilize foods. Higher doses of irradiation are used to sterilize medical supplies and other nonfood items.

Figure 1. Schematic of a Gamma Ray Facility

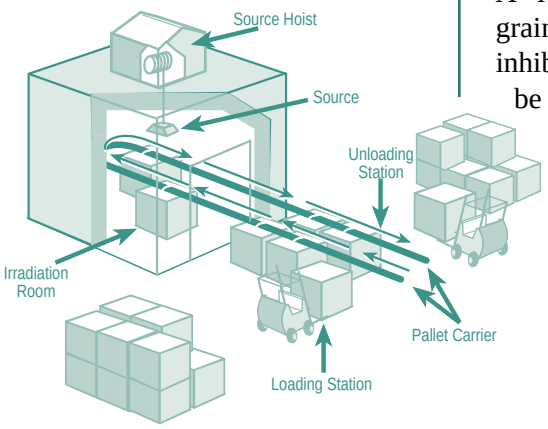


Figure 2. Radura Symbol

How Will I Know if Food is Irradiated?

Irradiated foods that are sold at retail markets are required by the FDA to bear the irradiation symbol, the "radura," and the statement "treated with radiation" or "treated by irradiation." Manufacturers may add a phrase that truthfully describes the purpose of the treatment, such as "treated with radiation to control spoilage." For unpackaged fruits and vegetables, labels could be on each piece of produce, on the shipping container that can be viewed by consumers, or on a sign near the display of the produce. For irradiated foods sold at the wholesale level, the symbol and wording are still required, as is the statement "do not irradiate again." If foods are incorporated into other foods as ingredients, the resulting products do not require labeling.

Changes in Foods

Foods that have been irradiated at the approved energy levels are not radioactive. At the low levels of radiation used in food processing, only chemical changes are possible. Sensory properties and vitamin retention may be adversely affected unless temperature, dose rate, absorbed dose and packaging are controlled. Over 35 years of research suggest that changes in irradiated food are very similar to changes that occur when food is conventionally cooked. No toxic or mutagenic effects have been found in irradiated food, and irradiation does not leave chemical residues in food.

Food irradiation is a "cold" process, meaning there is only a slight increase in the temperature of the food during the process. There is little, if any, change in the physical appearance of irradiated foods. They do not undergo the changes in texture or color as foods preserved by heat pasteurization, canning or freezing. Some off-flavors in meat and excess tissue softening in fresh peaches and nectarines have been reported, particularly when higher than necessary dose levels were used. Research conducted at Kansas State University concluded that ground beef flavor, juiciness and tenderness were not adversely affected by irradiation at the levels used. Scientists also concluded that chilled and frozen ground beef patties irradiated at 1.5 and 3.0 kGy, did not show any adverse effects on vitamin retention (specifically thiamin and riboflavin) or meat color.

Some chemical changes occur in irradiated foods, but these changes are not unlike chemical changes resulting from conventional cooking. When high energy particles impact matter, electrons are lost from atoms, and new ions form. These newly formed "radiolytic" products may then interact to create new compounds; a few of these reactions may produce an off-flavor. The FDA

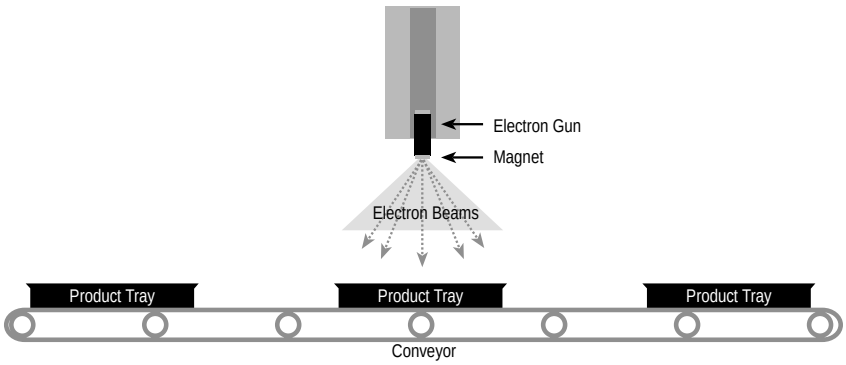


Figure 3. Electron Beam Irradiation

What are Some Foods Approved for Irradiation?

1963	Wheat, flour	Control insects
1964	White potatoes	Inhibit sprouting
1985	Pork	Control *Trichinella spiralis*
1986	Fruit	Slow ripening, control insects
1986	Vegetable	Control insects
1990	Poultry	Control bacteria
1997(FDA) Meat and 1999(USDA)		Control bacteria

concluded "very few of these radiolytic products are unique to irradiated foods; approximately 90% of the radiolytic products are known to be natural components of food."

Economic studies have shown that food irradiation will only add a few cents a pound to the product. Consumers are slowly gaining knowledge about the benefits and minimal costs they will have to pay for irradiated foods. The potential to reduce the risk of foodborne illness is finally being recognized by consumers, but this process is not a replacement for proper food handling practices.

Pasteurized Ground Beef

In May 2000, test markets of irradiation pasteurized ground beef began in the Twin Cities of Minnesota and at other locations in the United States. The product was made available June 16 in a Florida test market. Several participating supermarkets sold out of the ground beef, as consumers valued the enhanced safety of the irradiated products. According to Randy Childers, Meat Manager for Wyndle's, one of the supermarkets, "Consumers ... want the dual health benefit a 90 percent lean, premium quality product with an extra measure of protection against foodborne pathogens." Consumers, however, will still need to use good food handling and sanitation practices when preparing irradiation pasteurized meat.

Glossary of Terms

Cobalt 60: An isotope, which is most commonly used in food irradiation, that can give off ionizing energy. Energy radiations from cobalt can penetrate food deeper than electrons.

Electron beam: Produced from machines capable of accelerating electrons. Electrons can not penetrate very far into the food, compared to rays from cobalt or x-rays.

Food irradiation: The process of exposing food to radiation or rays of energy.

Ionizing radiation: Rays of energy that move in short, fast wave patterns and can penetrate cells.

Radura symbol: A circular symbol that must appear on all irradiated food sold at wholesale and retail levels.

X-rays: Radiation produced by a machine source. Compared to electrons, they penetrate deeper into the product.

For More Information

Webb, M. and K. P. Penner, *Food Irradiation,* MF-2426, K-State Research and Extension, Feb 2000.

U.S. Department of Agriculture
http://www.fsis.usda.gov

U.S. Food and Drug Administration
http://www.fda.gov/opacom/catalog/irradbro.pdf

http://vm.cfsan.fda.gov/~dms/fdirrad.html

Q / A

T or F	Irradiation does not make food radioactive.
T or F	Many irradiated foods have been in the marketplace for years.
T or F	The label symbol for irradiated foods is called the “radura.”
T or F	If consumers choose irradiation pasteurized meats, they will no longer have to follow traditional safe food handling practices.

NOTES

Examples of Products (old and new technologies)

Classical fermentations for preserving or developing flavors in food:

- Yeast and molds to make cheeses such as blue, brie; bread; wine; soy sauce; and beer.
- Bacteria to make yogurt, cheeses, summer sausage, saurkraut, pickles.

Enzymes (specialized proteins)

- Chymosin (rennet) for cheese-making
- Lactase tablets to break down lactose sugar in milk (for people who cannot digest lactose)

Hormones

- Insulin
- Bovine growth hormone - (bovine somatotropin) supplements given to dairy cows to increase milk production

Whole foods – certain varieties of the following:

Soybeans
Corn
Canola
Rice
Tomatoes

GENETIC ENGINEERING A Type of Biotechnology

Beginning as far back as 1800 B.C., our ancestors began to use biotechnology to ferment wine or to make yeast-leavened bread. By the 1860s cross-pollination was used to breed plants with desired characteristics. Most plant and animal foods in our food supply today — livestock, potatoes, corn, wheat, rice, tomatoes — were developed through these breeding techniques. But cross-breeding is uncertain and it takes a long time. When a plant is cross-bred, for example, all of the its 100,000 or so genes are mixed randomly. To obtain the few desired characteristics, breeders have had to spend years back-crossing with original plants to breed out all of the undesirable genes that crossed with the ones desired. Genetic engineering, however, brings greater precision to the breeding process and allows for crossing of genetic material between species. Instead of cross-breeding for years to obtain the desired trait, it is now possible to insert single or only a few **genes** into a plant to obtain the desired trait. Thus, genetic engineering, as this process is known, is both precise and fast!

Biotechnology means "the study of living tools." Another way to say this is "applied biology." Yet another definition is "using living organisms to make a product or run a process." Biotechnology is applied in agricultural production, food processing, industrial production, environmental clean up and medicine. "Old" biotechnologies include using yeasts (living organisms) to ferment sugar in bread-making. Other organisms are used to make yogurt, cheeses and some sausages. Traditional plant breeding techniques also fall under the old category. "New" biotechnologies include "genetic engineering." In genetic engineering, scientists modify the genetic material of living cells to produce new substances or to perform new functions. It is this new, powerful technology that is used today to produce insulin, new Round-up ™ Ready soybeans, *Bt* corn, and Golden Rice. It is also the subject of some controversy.

What is Genetic Engineering?

Genetic engineering is also referred to as **recombinant DNA** technology. One copy of a piece of DNA (genetic material) from one organism (bacteria, plant, animal) can be copied and transferred to another organism where it is " recombined." The second organism is genetically changed or modified. In Europe this is termed a "genetically modified organism" or GMO. In the U.S., we are more likely to describe the resulting product as "genetically engineered." Recombinant insulin is produced using this technology. A copy of the gene for insulin is inserted into bacteria. The genetically engineered bacteria then produce the insulin. It is purified and can be used to treat humans with diabetes. Prior to the use of this technology, insulin was obtained from the pancreas of slaughtered animals such as swine or sheep.

Genetic engineering is more precise than the older methods of breeding new traits into plants and animals. For example, traditional corn breeders have mixed thousands of genes from two different types of corn to make one new hybrid corn variety. Using genetic engineering, however, scientists can transfer only one or two specific genes from corn, from bacteria, or even from other plants or animals to make a new corn variety.

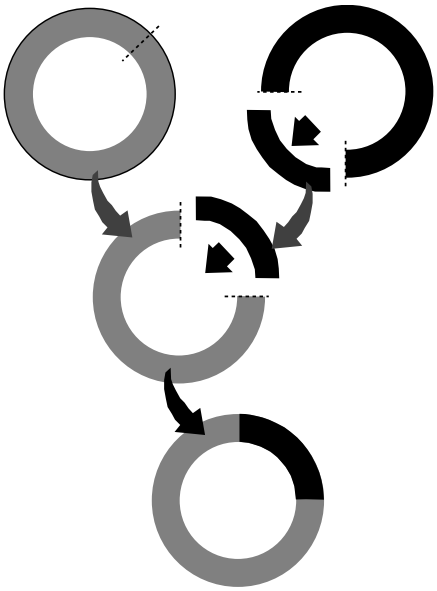


Figure 4. Recombinant DNA

You can think of gene splicing like cutting a circle of tape. You can cut it once, insert a different piece and join ends.

What are the Benefits?

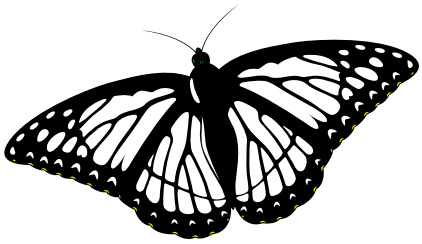
The world population is expected to reach 9 billion by 2050. Genetic engineering, rDNA technology, is a tool to help increase global food production. How? By engineering into crops these characteristics:

- **Increased resistance to pests and diseases.** This reduces the need for chemical pesticides, reduces the chances of crop failures and increases yield of crops.
- **Tolerance of adverse conditions.** Growing conditions such as drought, poor soils, and extreme temperatures affect plant growth and the amount of crop harvested. Plants can be engineered to overcome harsh conditions.
- **Tolerance of herbicides.** Herbicides that control weeds, but do not affect the planted crop are quite useful. Crops grown with exposure to these herbicides require less tillage for weed control. Thus, fuel and time are saved, and the soil is less susceptible to erosion.
- **Functional characteristics.** Crops can be engineered to have lower amounts of allergens, delayed ripening, increased starch content, longer shelf-life and more. These are all "functional" properties of the usable product.
- **Enhanced nutritional qualities.** Products may be engineered to contain a desired nutrient or increase the amount of a nutrient already present. These modified crops may greatly improve the nutritional status of a population of people.

Some Issues

The older methods of breeding did not allow the moving of genes from one organism to a totally different species. Moving genes from one species to another concerns some people. Some are concerned about the ethics of transferring genes, others are concerned about safety issues, some just want genetically engineered foods to be labeled, and some are concerned that genetically engineered crops and food products will not be welcome on the world market.

Are Monarch Butterflies Affected?



One genetically engineered corn variety known as *Bt* corn was designed to be toxic to the European corn borer, reducing the need for chemical pesticides. The corn borer belongs to the Lepidopteran order of insects, and so do monarch butterflies. When corn borers are in the larvae stage and feeding on corn stalks, they will die. If monarch butterfly larvae feed on corn pollen of some varieties of *Bt* corn, they will also die. But, monarch butterflies prefer milkweed plants over corn, thus, the monarch butterflies would not be harmed under normal conditions. The only way they would be exposed is if milkweed plants grew next to corn fields planted with *Bt* corn, and if the pollen "drifted" from the corn to the milkweed plants. Research is underway to study the situation. However, one study notes that the population of monarch butterflies has actually increased since farmers began planting *Bt* corn. Farmers who plant *Bt* corn use less pesticide, so fewer insects are harmed. Pesticide drift from the corn field to neighboring farms and ditches would kill many species of insects including the European corn borer, monarch butterflies, and other insect species residing in the fields and ditches.

Regulation of Genetically Engineered Foods

The U.S. Food and Drug Administration, the USDA, and the Environmental Protection Agency have some regulatory authority for genetically engineered foods, depending on the product. There is a process by which companies must submit test results and have products reviewed. The federal agencies do not test products themselves, but they require companies to subject new products to rigorous review before releasing them. Such testing is for possible allergens that might be transferred or developed in the new product, safety, effectiveness of action of the newly engineered trait, and more. In fact, this process was recently strengthened. There is, however, no requirement to label genetically engineered foods unless the new product is substantially different than the original. Then, nutrition labeling or some other label indicating the difference in the product may be required. In some cases the food might need a brand-new name. Foods do not require labels to indicate how they were developed.

Answers to Q/A, Pages 4,8: T,F,T,F

For More Information

U.S. Department of Agriculture

http://www.aphis.usda.gov/biotechnology/

U. S. Food and Drug Administration

http://vm.cfsan.fda.gov/~lrd/biotechn.html

K-State Biotechnology Information

http://www.oznet.ksu.edu/biotech/

K-State Research and Extension Food Safety

http://www.oznet.ksu.edu/foodsafety

Glossary of Terms

Biotechnology - Using living organisms to make a product or run a process.

DNA - Primary genetic material. The spiral information tape that stores genetic information in organisms and transmits the information from generation to generation.

Fermentation - Using an organism — yeast, mold or bacteria — to change complex chemicals into simpler substances. For example, using yeasts to break down sugar and produce carbon dioxide gas and alcohol in the rising of bread dough.

Genes - For genetic engineering, the smallest portion of a chromosome that contains hereditary information for the production of a protein.

Genetic engineering - Using recombinant DNA techniques or other methods to move one or several genes from one organism to another, to arrange one or several genes within a cell, or to alter gene-controlled processes.

Recombinant DNA (rDNA) technology - Technique of taking copies of genes from one organism and inserting them in another organism, which can be totally unrelated.

Q / A

T or F	Traditional plant breeding is a type of biotechnology.
T or F	Biotechnology is a very recent technology.
T or F	Using genetic engineering, a gene from one organism can be transferred into the genetic material of another organism.
T or F	All foods produced by genetic engineering are required to be labeled.

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