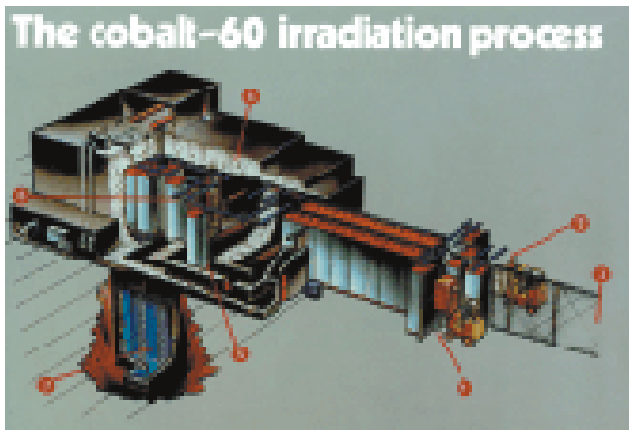


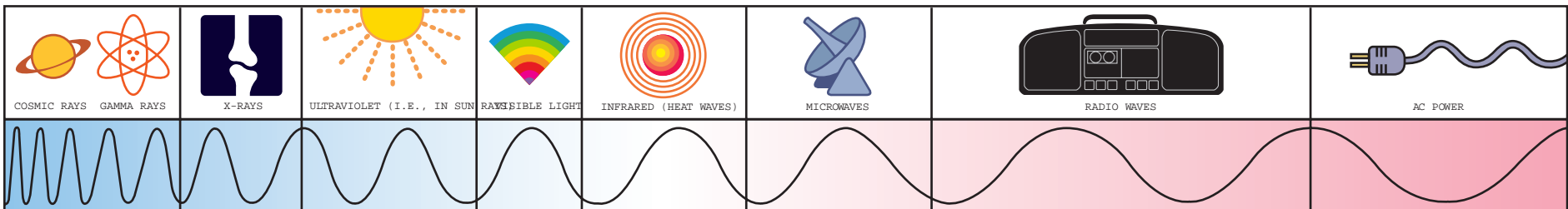
FOOD IRRADIATION

What is Food Irradiation?

Food irradiation is the treatment of food by gamma rays from a cobalt-60 or cesium-137 source or electrons or X-rays from a machine source. It is analogous to other types of food processing treatments such as heat pasteurization, canning, freezing or dehydration. Irradiated foods are safer to eat and more resistant to spoilage. Irradiation destroys insects, molds, fungi, and pathogens that cause food-borne illness or foods to spoil. Irradiation temporarily ionizes (electrically charging) atoms or molecules by knocking electrons out of their normal orbits. It is stressed that the foods do not become radioactive.



- 1 Food being loaded into containers before irradiation.
- 2 Unloading irradiated food.
- 3 Screen to separate irradiated from non-irradiated food.
- 4 Concrete shielding to contain radiation.
- 5 Entry and exit maze designed to prevent leakage of radiation.
- 6 Irradiation chamber where food is exposed to radiation from the cobalt-60 source.
- 7 Storage pool for cobalt-60 when not in use.



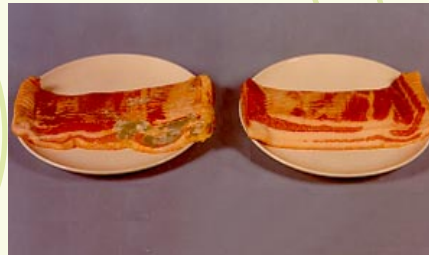
Electromagnetic Spectrum of Energy

What are the benefits from using food irradiation?

The table below lists some examples of treatment levels and the desired effect on the food item.

| TYPE OF FOOD | DOSE IN kGy* | EFFECT |
|--|--------------|--|
| Meat, poultry, fish, shellfish, some vegetables, baked goods, prepared foods | 20-70 | Sterilization. Treated product can be stored at room temperature. |
| Spices and other seasonings | 8-30 | Reduces number of microorganisms and destroys insects. Replaces chemicals. |
| Meat, poultry, fish | 1-10 | Pasteurizes to protect against pathogens (<i>Salmonella</i> , <i>E. coli</i>) and delays spoilage. |
| Strawberries and some other fruits | 1-4 | Extends shelf life by reducing or eliminating molds and fungus. |
| Grain, fruit, vegetables | 0.1-1 | Kills insects or prevents them from reproducing. Could partially replace fumigants. |
| Bananas, avocados, mangoes, papayas, guavas and other noncitrus fruits | 0.25-0.35 | Delays ripening. |
| Pork | 0.08-0.15 | Inactivates trichinae. |
| Potatoes, onions, garlic | 0.05-0.15 | Inhibits sprouting |

*kGy (kilogray). When a kilogram of matter absorbs the energy of one joule, this matter is said to have received a dose of one gray.



The above fresh fruits and vegetables were given a low dose (1-2 kGy) of irradiation to extend shelf life. The additional shelf life allows many products to be shipped overseas, thereby increasing the menu selection and acceptability. The bacon was given a high dose (25 kGy) to extend shelf life and significantly reduce the amount of nitrites required to cure the product.

A label from a commercially available spice line

Purely By Choice spices are produced in the U.S. for individuals who need and want the safest foods. Each has been processed by gamma irradiation to safely reduce existing bacteria & molds that are common to earth-grown foods.

No chemicals or fumigants are used in this process. Thus, the product's natural qualities and wholesomeness have been retained.



THE SYMBOL OF QUALITY
AROUND THE WORLD...

Purely by Choice®
A Healthy Alternative

OREGANO



Treated by Irradiation For Maximum
Safety & Wholesomeness
Net Wt. .62 oz.

Food irradiation is recognized as safe by medical, scientific and food safety experts around the world, including the following:

- American Medical Association
- U.S. Department of Agriculture
- U.S. Food and Drug Administration
- Institute of Food Technologists
- Council for Agricultural Science & Technology
- American Council on Science and Health
- United Nations' Food and Agriculture Organization

Distributed by LoBac Products
Fullerton, CA

What are the more specific benefits that the military user could expect in the food arena?

There is a continuing need to enhance the quality and acceptance of operational rations. Longer shelf life, safety enhanced, perishable foods would significantly impact field and shipboard feeding by improving the logistics of distribution and storage. Irradiation-processed products could support various field feeding systems, increase the variety of familiar foods, decrease losses due to spoilage and decrease the risks of food borne illness.



Many of the most commonly eaten foods can be irradiated to improve shelf life, reduce the food-borne pathogens or provide added flexibility in menu selection.

The benefits can be grouped into three categories:

- Provide safety enhanced chilled items such as pasteurized poultry, luncheon meats and fresh extended shelf life produce.
- Incorporate shelf-stable, familiar, conventional foods, such as sirloin steaks or ready-to-eat sandwiches, into operational rations.
- Improve the distribution and storage, simplify resupply and reduce the reliance on refrigerated and frozen storage facilities.

NASA has used irradiated foods since the 1970's. Currently two entrees, grilled beef steak and smoked sliced turkey, are regularly provided to NASA's space shuttle program through a joint agency Memorandum of Understanding. Additional products, such as beef teriyaki, breakfast sausage and BBQ beef brisket, are being developed for the International Space Station. Products like these could be utilized by the Meal Ready-to-Eat program in the future.



What are the logistical benefits from using irradiated foods?



A good example is the 29-ounce can of chicken pieces used in the B Ration program. The photo at left shows the traditionally thermo-processed canned chicken and the irradiated counterpart. The tables below show the associated cost to irradiate and the further breakout of costs per serving throughout the packing and shipping steps.

Irradiation and its Effect on Cost Example: Chicken, 29 oz. B Ration

| | THERMOPROCESSED | IRRADIATED |
|---------------------------|---------------------------------|--------------------------------|
| COST/CAN | \$4.72 | \$4.81 |
| Net Weight (29 ounces) | 15 oz. chicken 14 oz. liquid | 27 oz. chicken 2 oz. liquid |
| 3 oz. Portion | 5 Portions | 9 Portions |
| Cost/Serving | \$0.944 | \$0.534 |



The irradiated item, unlike the thermoprocessed chicken, does not need to be used in a casserole but can be sliced and eaten like a whole muscle product.

Economics of Irradiation Example: Canned Chicken, 29 oz. B Ration

| | THERMOPROCESSED (PER SERVING) | IRRADIATED (PER SERVING) |
|--|----------------------------------|-----------------------------|
| Per Can | 5 | 9 |
| Per Case | 120 | 216 |
| 30 Cases/Pallet | 3600 | 6480 |
| 30 Pallets/Trailer | 100800 | 181440 |
| Dry Shipment (OCONUS) \$2467/Trailer | \$0.0244 | \$0.013 |

What is the history of food irradiation and how does the military play a role in this technology?

- 1895-96 Roentgen discovered X-rays. Becquerel discovered radioactivity.
- 1905 Patent granted to improve condition of food with irradiation.
- 1921 US patent for irradiation of pork for trichina.
- 1930 French patent for X-ray preservation of foods.
- 1950-70 More powerful sources available; major research programs begun; FDA approves some items.
- 1980 Food and Agricultural Organization/International Atomic Energy Association/World Health Organization Expert Committee issue blanket approval for any food irradiated up to 10 kGy.
- 1983 Codex Alimentarius endorsement.
- 1980s FDA approvals for spices, pork, enzymes, fresh fruits and vegetables.
- 1992 FDA approval for pasteurized poultry.
- 1997 FAO/IAEA/WHO study group issues approval for high dose products, FDA approval for red meat pasteurization.

Are irradiated foods nutritionally equivalent to other processed foods and have they been safety tested?

Irradiated foods are nutritious and safe to eat. When compared to other processed foods, irradiated foods retain equal or more of the vitamin content. This is due to the fact that irradiation is a cold process instead of a high heat process. Overall, the nature and extent of irradiation processing changes depend on the composition of the food, the dose, the temperature, and the presence or absence of oxygen.

The safety of irradiated foods has been proven in hundreds of independent studies from around the world. The largest study ever undertaken was done by the U.S. Army Medical Department. The study parameters and conclusions were as follows:

Safety Study Background:

- Started in 1976 and lasted seven years
- Cost \$8 million
- Consisted of 20 research projects; examined the effects of sterilized chicken with respect to: nutritional quality; reproductive performance; genetic toxicity; teratogenicity; toxicity.
- Test species: dogs, rats, mice, hamsters, rabbits and fruit flies.

Conclusion: No evidence of any mutagenic, carcinogenic or toxic activity.

Historical Development of Irradiation -- The U.S. Army Impact

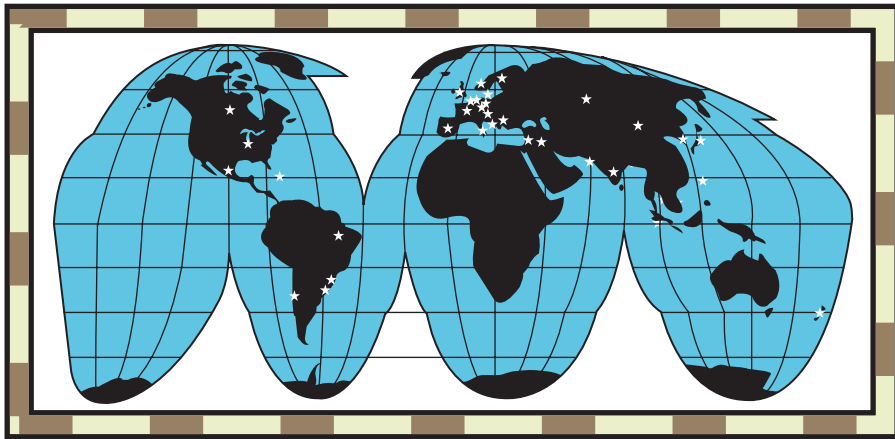
- 1943 Army sponsored feasibility study at MIT.
- 1953 Army/Quartermaster assigned food irradiation program lead.
- 1953 Atoms for Peace policy set by President Eisenhower.
- 1962 Completion of U.S. Army Natick's irradiation facilities.
- 1960-80 US Army Natick conducts extensive microbial, chemical, food processing and engineering food irradiation studies.
- 1991 Army (Natick) rejoins irradiation program.

Major Army Achievements

- Technology developed to produce high quality, shelf stable, pre-cooked, vacuum packed entrees.
- FDA clearance of packaging for use with irradiated foods.
- Development of theoretical and experimental criteria for determining the minimum required dose to assure the elimination of pathogens.
- Conducted world's largest wholesomeness study of high dose irradiated foods.

Who supports food irradiation?

American Dietetic Association
American Medical Association
American Veterinary Medical Association
American Meat Institute
Council for Agricultural Science & Technology
Food and Agriculture Organization (United Nations)
Institute of Food Technologists
Kiplinger Agricultural Letter
Mayo Clinic
National Center for Food Safety
Prevention Magazine
U.S. Department of Agriculture
U.S. Food and Drug Administration
U.S. Public Health Service
World Health Organization



Who uses food irradiation?

| | | |
|----------------|-------------|----------------|
| Argentina | Germany | Philippines |
| Bangladesh | Hungary | Poland |
| Belgium | India | South Africa |
| Brazil | Indonesia | Spain |
| Bulgaria | Israel | Syria |
| Canada | Italy | Taiwan |
| Chile | Japan | Thailand |
| China | Korea | Russia |
| Cuba | Mexico | United Kingdom |
| Czech Republic | Netherlands | USA |
| Denmark | New Zealand | Uruguay |
| Finland | Norway | Vietnam |
| France | Pakistan | |

What is currently being irradiated?

FOOD ITEMS

Citrus, tomatoes
Potatoes, onions, garlic
Strawberries
Papayas, mangoes
Mushrooms
Avocado pulp
Spices, herbs, tea
Beans and legumes, lichis
Grains, flour
Chicken, pork, sausages
Shrimp, fish, oysters, frog legs
Frozen juice concentrates
Pickle products
Rice, yeasts
Dried fruits and vegetables
Cherries, raspberries, grapes, currants
Dates, cocoa beans
Gum arabic, nutraceuticals
Meusli-type cereals and others
Apricots and pears
Asparagus, peppers
Various breads
Red meats
Hospital meals for immunocompromised patients

OTHER ITEMS

Animal feeds
Enzymes
Baby bottle nipples, pacifiers
Bandages, sponges, gauze
Dry blood protein
Baby powder, talcum powders
Beehives
Ornamental horticulture
Potting soil, woodchips
Contact lens solution
Tobacco
Medical devices and instruments
Cosmetic ingredients
Cotton swabs, cotton balls
Rubber for tires
Electrical wiring
Prescription bottles
Pharmaceutical ingredients
Packaging materials
Petri dishes and labware
Surgical garb, towels

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Natick, MA 1998