THE FUTURE OF FOOD IRRADIATION IN THE UNITED STATES

Raymond W. Durante
The Food Safeguards Council, Inc.
1925 North Lynn Street, Suite 725
Arlington, Virginia 22209 USA
Fax: 7033-276-8447
E-mail: durantes@aol.com

Good morning ladies and gentlemen. I am very pleased to be here as a representative of the American Nuclear Society and the Food Safeguards Council to discuss food irradiation and its future use in the United States. I have deliberately chosen not to make this paper a technical discussion of the food irradiation process or the equipment used in this process but instead focus on the status of this technology and its potential for commercial application. As you will see from this slide, food irradiation is a proven and accepted technology used throughout the world for more than 40 years and endorsed by many of the world's leading technical and societal organizations. Significant research has been done and it is safe to say there are no major technical barriers to overcome to make this process work. The real problem with food irradiation is public acceptance and understanding its benefits versus possible risks.

I will begin by describing what food irradiation is and what it is not. Food is irradiated using ionizing energy in the form of gamma rays from radioactive isotopes, x-rays, or electrons from paticle accelerators. By exposing food to this ionizing energy, insects, molds and fungi are destroyed as well as microbial pathogens that cause food to spoil and can result in food-borne illness. It is important to understand that food irradiation is analogous to other food processes such as heat pasteurization, canning, freezing, or dying. In fact, it has been shown that irradiation has far less effect on the consistency, quality, taste, and appearance of food than other more widely accepted processes. Food irradiation can be compared to microwaving as microwaves pass through the food for the purpose of cooking but do not cause the food to emit microwaves once the process is stopped. Unlike microwaves, the amount of energy used to process food by ionizing energy is relatively low and little heat is produced. There are no hot fluids or gases that could generate an explosion or radioactive gases, liquids, or solvents that could be accidently disseminated into the surrounding environment. There are no known ways in which the sources could be used to produce nuclear weapons. Facilities used to treat food with ionizing energy are very different from those required in power plants or weapons production in that they contain no uranium or other fissionable material and no source of neutrons to produce fission.

When food is cooked, significant amounts of heat are added and chemical reactions take place that change the nature and appearance of the food. In contrast, ionizing energy penetrates food virtually instantaneously and as a result the molecules that form when food is exposed to ionizing energy are not a new breed of compounds but the same kinds of compounds encountered in untreated food and in food processed by other methods. No chemical compounds have ever been found in food treated with ionizing energy that have not been found in corresponding unprocessed food or in food processed by other accepted methods. An enormous amount of data and information describing technical processes that take place when food is irradiated is available and some of it is referenced at the end of this paper. This technology has been with us for over 50 years.

Food irradiation is not a substitute for cleanliness and safe handling packaging and storage of foods, and is not a cure for foods that are spoiled, infected, or diseased. (For example, if you froze or microwated spoiled meat, it would still be unsuitable for consumption). The same logic

applies to food irradiation. Based on the accumulation of scientific data, some of which is given in the list of references following this paper, I can assure you the technical processes involved in food irradiation are safe and acceptable when used properly and under controlled levels of irradiation.

Why is food irradiation so important? Originally, it was thought food irradiation would be an excellent way to preserve food and in particular inhibit post-harvest sprouting of tubers and bulbs and delay ripening of soft fruits and vegetables. In addition, ionizing energy can eradicate certain insect pests that are detrimental to food production, such as the fruit fly and other parasites that infest raw fruits and vegetables as well as harvested and processed grains, wheat, and corn, and various kinds of spices. All of this is true and by itself would be more than sufficient justification to use food irradiation as a wide-spread food processing technique. We know, for example, that more than 25 percent of the world's food supply is lost due to spoilage and infestation. If one could reduce this loss by using food irradiation, it would go a long way towards combating world hunger. But there is an additional and perhaps more important benefit from food irradiation and that is to eliminate or reduce micro-organisms, parasites, and pathogens in food that cause food-borne illnesses and even death. In January 1993, in the western USA, an outbreak of E-Coli occurred and two children died and more than 400 people became ill from eating tainted hamburger at a fast food restaurant. This is a dramatic example of ongoing statistics which show that more than 50 million cases of food-bourne illness occur each year resulting in 9,000 deaths. Today in the United States there is an increasing awareness that food quality is a growing problem. As more and more food is subject to mass production techniques for harvesting, processing, and handling it becomes increasingly difficult to prevent the introduction of food-borne pathogens such as salmonella, trichinosis, and the deadly E-Coli 157:H7. Treating foods, particularly poultry, fish, and meat, with steam or chemicals is of questionable effectiveness and produces undesirable side effects. Irradiating food is a sure way to protect against food becoming diseased.

To give you an idea of some of the food items that can be irradiated, this slides lists vegetables, fruits, and meats. I assure you these are just indications of particular foods that are more routinely irradiated.

The next slide shows the beneficial effects of food irradiation and the level of dose that is applied. Dose rates needed to irradiate food are described in Kilograys (KGY). One kilogray is equivalent to one kilojoule or 240 gram calories/kilogram of material. For example, strawberries exposed to 2 kilograys of ionizing energy inhibit molding, that occurs during storage, for an additional 2 weeks. It can be a very important factor in harvesting and shipping. Through this process more strawberries, for example, would be available to more people throughout the world. The U.S. Food and Drug Administration approved the use of food irradiation to help control salmonella in poultry feeds. There are a number of theories that place the orgin of the salmonella pathogen in the feed rather than the animal. The U.S. Department of Agriculture amended meat inspection regulations to provide irradiation of poultry products.

A serious problem in the United States is the high percentage of poultry products found to have salmonella pathogens present. Salmonella is almost always on the skin of poultry which is the first portion to be cooked and, therefore, salmonella poisoning from the poultry itself is not very prevalent. On the other hand, raw chicken contaminated with salmonella and placed on another surface, such as a cutting board or china plate, will transmit pathogens which can easily be picked up by other foods. More and more incidents of salmonella poisoning are being detected as a result. There are many other examples in which the Food and Drug Administration approves the use of food irradiation. Under 21CFR179 regulations to control trichinella spiralis in fresh pork; inhibit the growth and maturization of fruits and vegetables; and the disinfestation of arthropods in food. Currently, one of the most wide-spread uses of ionizing energy is for the microbial disinfection of dried spices and dried vegetables seasonings. Today food irradiation is used in more than 47 countries throughout the world as shown on the slide.

Irradiating food is certainly not new. In fact, it surprised me to find that in 1921 a patent was issued for the use of ionizing energy to kill trichinella in pork. In 1943 the U.S. Army sponsored studies on this technology and became a major user of irradiated food. Obviously their intent was to preserve food and reduce spoilage when used in the field in the absence of refrigeration. While the first applications of food irradiation were successful by all means and measures, for reasons not entirely clear, the Army no longer irradiates food but relies on the effective transport and refrigeration systems to keep food fresh and available. On the other hand, NASA (the National Air and Space Agency) supplies the astronauts with irradiated food on space flights. In fact, NASA is one of the largest users of irradiated food and continues to use irradiated products such as ham, which was first used on Apollo 17 in 1972; and beef steak, turkey and cornbeef; and bread, used on the Apollo and first five shuttle missions. More than 400 servings of irradiated beef, cornbeef, and smoked turkey were eaten between 1981 and 1986. No refrigeration was required for this food and the assurance there were no potential pathogens protected the astronauts as well as preserved the integrity of space making sure we were not introducing harmful bacteria into that environment. NASA worked with the U.S. Army at the Nadick Center in Massachusetts where they jointly researched food irradiation and actually prepared the meals. It has been reported that the food was very popular with the astronauts. In fact, the Russians preferred U.S. meals because of the wider variety.

As early as 1970, the U.S. Food and Drug Administration approved a few applications for food irradiation. In 1981, the World Health Organization Expert Committee recommended that food irradiation would be a beneficial process. In 1983, the Codex Allementarious endorsement was probably the most significant and far reaching statement of support for this technology. Following that, the USFDA approved the irradiation of poultry and in 1994 received the red meat petition. However, even with the incident of deaths resulting from eating tainted hamburger, no progress has been made with this petition and food irradiation in general has been dormant. Unfortunately, food irradiation became a victim of public concern that is so commonly applied to all things nuclear. I am sure you all know that beginning in 1980, there was a strong anti-nuclear movement in the United States. In fact, following the Three-Mile Island and Chernobyl accidents, no new nuclear plants have been ordered. In the mid and late 1980s, a number of anti-nuclear organizations were formed by well meaning, but misinformed citizens opposed to food irradiation. The most visible of those organizations, Safe Food and Water originally headed by a physician, embarked on a public relations campaign that traded on misinformation and fears about nuclear irradiation. For reasons completely unknown to me, this organization conducted an almost religious crusade to stop the use of irradiated food. Many food packaging companies were just beginning to be interested in the possibility of using irradiated food; however, if there was ever any indication they might market this food, Safe Food and Water would immediately set up pickets and start public relations campaigns to frighten consumers and prevent tham from buying any irradiated food. States such as Maine, New Jersey, and New York banned irradiated food. There was a great deal of publicity coincident with these state actions. The U.S. General Accounting Office studied the ban on irradiated food in these states and in their May 1990 report said that the bans produced by these states were in response to public concern rather than as a result of scientific evidence showing food irradiation to be unsafe. Yet, it is well known that the public, while apprehensive about irradiated food, are more than willing to purchase and consume irradiated food when the process is explained in detail to them. A 1993 study by Purdue University found that peoples attitudes improved markedly after they learned the science and technology. In this study, two groups of adults were shown a seven minute educational video on food irradiation and polled before and after the video. One group's acceptance of food irradiation grew from 54 percent to 90 percent and the other group rose from 69 percent to 99 percent. Studies by Dr. Christine Bruhn at the University of California and others showed that the consumer, in most cases, is the person in the family most responsible for preparing meals. They were interested primarily in the safety of food for their family and when it was explained that irradiated food is safer than non-irradiated food, they were willing to purchase it.

Despite all this there is no industry in the United States, per se, that produces irradiated food in quantity. There is one plant in Florida that has operated for many years against overwhelming odds from anti-nuclear groups and anti-food irradiation groups picketing it and interfering with its operations. Opponents can use the NRC licensing process to delay issuance of construction permits to any nuclear facility, placing serious financial penalty on the owners.

The next slides gives you an indication of the kinds of literature produced by the anti-organizations. On the other hand, information supporting food irradiation is usually found primarily in scientific and technical journals which are less available and far less appealing to the public.

Early this year a movement was started by the U.S. government to improve food safety. Vice President Gore declared he would lead a fight against distribution of diseased food to the public. More than $40 million was mentioned as the amount needed for a concerted effort by the Environmental Protection Agency, the Department of Agriculture, and the Department of Health and Human Services. A three day conference in Washington, DC was held and people came from throughout the country to support the need for improved food safety. While there were many suggestions for ways to improve food safety, most dealt with after the fact actions, such as inspection and regulatory improvements. Very little was said about processes such as food irradiation that prevent the onset diseases. I was one of the very few speakers at that conference who suggested we needed to examine ways to prevent food from becoming diseased rather than just inspecting and regulating it. I proposed the government look at food irradiation once again as it had been in the 1950s and 60s and support this process. I also volunteered the services of the American Nuclear Society and the Food Safeguards Council to work with this group to investigate how these processes could be implemented. To date we have had no response and there appears to be no interest on the part of the federal government in undertaking any processes that involve nuclear energy.

Where does this leave us in the United States. We have a beneficial technical process that can bring great good to mankind and we simply cannot get it off the ground. The only dedicated food irradiator in the U.S. is in Florida operated by Food Technology Services, Inc. This is a water-cooled, Cobalt-60 source facility licensed by the NRC. It has been operating for some time irradiating fruits, vegetables, and poultry parts. Initial sales of irradiated foods were from small "boutique" markets - the most popular in Chicago. They is reported consumers who bought irradiated food were completely satisfied and now prefer to purchase irradiated food. But in general there is no established industry to produce and distribute irradiated food. There have been some discussions about using electron beam accelerators to irradiate food and in this way avoid using radionuclides and allay public concerns. While this is certainly possible, it is clearly understood by the scientific community there are some limitation to using electron beams. Because depth of penetration is somewhat limited, only certain types of products can be irradiated and portability of such systems is quite expensive (see references 5 and 8).

It appears to be the classic chicken and egg problem. Food compaines would like to sell irradiated food to ensure the quality for their products but would also like to see it demonstrated and used by other companies. As one major company told me, "I would like to be second". A number of industries are prepared to build food irradiators but need to be assured a market exists before they make the investment. In my judgement, the only way to solve this problem is through courageous and aggressive leadership on the part of our government an the scientific community who have the ability to assure the public that this is a safe and beneficial process. This is not easily done in the United States; however, in countries such as China and India, there is much wide acceptance of food irradiation. It is important the facts be brought to the public and the negative publicity generated by opponents must be countered. Consumers should be informed of the benefits and safety of irradiated products. Regulations between nations will have to be

harmonized and food irradiation needs to be cost-effective compared to other methods before food processors are willing to invest in commercialization. Meeting these hurdles may be very difficult, but I can think of no more beneficial goal than to bring this process to a hungry and safety conscious world.

Thank you.

REFERENCES

1. Overview of Commercial Food Irradiation in the USA, Chin Cottee and Peter Kunstadt, September 1995.

2. Food Irradiation Update, Strategies for Ensuring Public Safety, Raymond W. Durante, ANS Executive Conference, April 21, 1996.

3. Facts About Food Irradiation: A Series of Fact Sheets From the International Consultative Group on Food Irradiation, World Health Organization, October 1990.

4. Final Report of the Committee on Interagency Radiation Research and Policy Coordination, Office of Science and Technology Policy, September 1995.

5. Ionizing Energy Produced by Accelerators for Food Processing, Raymond W. Durante, ANS Topical Meeting, November 1997.

6. Cold Pasteurization: An Answer to Food-Borne Illness, Harry C. Mussman, DVM, Ph.D., President and CEO, Food Technology Services, Inc., June 1996.

7. An Economic Perspective of Food Irradiation, Tanya Roberts, Economic Research Service, USDA, April 1996.

8. Radiation Processing with High Energy, High Powered Electronic Accelerators, Marshall Cleland, AECL Accelerators, April 1996.

9. Food Irradiation Update, Janet Collins Williams, Ph.D., RD, Vice President, American Meat Institute, April 1996.

10. Position of the American Dietetic Association on Food Irradiation, Journal of American Dietetic Association, January 1993.

11. Food Irradiation: Will Consumers Buy?, Christine M. Bhrun, Ph.D., Center for Consumer Research, University of California, Davis, April 1996.
12. Effective and Educational Pamphlets and Posters on Attitudes Towards Food Irradiation, Christine M. Bhrun, Ph.D., Center for Consumer Research, University of California, Davis, June 1986.

13. Consumer Attitudes and Market Response to Irradiated Food, Christine M. Bhrun, Ph.D., Center for Consumer Research, University of California, Davis, June 1995.

14. Irradiated Strawberries Enter the U.S. Market, M. Marcutte, Food Technology, Inc., June 1992.

15. Are Customers Willing to Purchase Irradiated Poultry? Anna Ressurection, Center for Food Safety and Quality Enhancement, University of Geogia, 1995.

16. Consumer Acceptance of Food Irradiation, Olivia Bennet Wood, Associate Professor, Department of Foods and Nutrition, Purdue University, 1996.

17. Food Industry Concerns and Challenges, Jeffrey Barach, National Food Processors Association, Washington, DC, April 1996.

18. Irradiation, Pasteurization of Food, Issue Paper 7, Council of Agricultural Science and Technology, Donald W. Thayer, April 1996.

19. Safety and Nutritional Adequacy of Irradiated Food, Pamphlet, World Health Organization, Geneva, Switzerland, 1994.

20. The Microbiological Safety of Irradiated Food, CodexAllimentarious Commission, CX/FH/83/9, Rome, 1983.

21. Safety of Irradiated Foods, Second Edition, Jay F. Diehl, Marcel Dekker, Inc., New York, 1995.

22. The use of Irradiation for Food Quality and Safety, Pamphlet, Institute of Food Science and Technology, March 30, 1997.

23. Ionizing Energy in Food Processing and Pest Control, Summary Report, Council for Agricultural Science and Technology, June 1989.

24. Health Physics Society Position Statement on Food Irradiation, July 1988.

WHAT IS FOOD IRRADIATION?

The treatment of food by ionizing energy in the form of gamma rays from radioactive isotopes, X-rays , or electrons from particle accelerators.

Irradiation destroys insects, molds, fungi, and microbial pathogens that cause food to spoil and can cause food-borne illness.

Foods treated in this manner last longer and they are safer to eat.

It is analogous to other food processes such as pasteurization, canning, freezing, or drying.

Slide 1

A BRIEF HISTORY OF FOOD IRRADIATION

1895	Roentgen discovered X-rays
1896	Becquerel discovered radioactivity
1905	Patent for improving foodstuffs
1921	Patent for killing trichina in pork
1930	Patent for x-ray treatment of foods
1943	U.S. Army sponsored studies at MIT
1950	Powerful radiation sources developed, major research programs started
1970	USFDA approved some food items
1981	WHO expert committee recommendation
1983	CODEX ailmentarius endorsement
1990--	USFDA approves more food items. Publicity becomes favorable
1995	Commercial use increases

Slide 2

SELECTED FOOD-BORNE PATHOGENS (1993)		
Pathogen	Total Cases	Total Deaths
Campylobacter, Jejuni or Coli	2,500,000	200-700
Colstridium Perfringens	10,000	100
Escherichia Coli 0157:H7	10,000-20,000	200-500
Listeria Monocytogens	1,795-1,860	445-510
Salmonella	800,000-4,000,000	800-4,000
Staphylococcus Aureus	8,900,000	7,120
Toxoplasma Gondii	4,111	82

Slide 3

WHAT FOOD ITEMS ARE IRRADIATED?		
Apricots	Garlic	Pickled Foods
Asparagus	Grains	Pork
Avocados	Grapes	Potatoes
Beans	Gum Arabic	Raspberries
Breads	Hospital Meals	Sausages
Cherries	Legumes	Shrimp
Chicken	Litchis	Spices
Citrus	Mangoes	Strawberries
Currents	Minced Meat	Tea
Dried Foods	Mixed Cereals	Tomatoes
Enzymes	Mushrooms	Yeasts
Fish	Onions	
Flours	Papayas	
Frog Legs	Pears	

Slide 4

BENEFICIAL EFFECTS OF FOOD IRRADIATION		
FOOD ITEM	**EFFECTS**	**DOSE (KGY)**
Meat, poultry, fish	Sterilization prevents spoilage	20-70
Spices, seasonings	Disinfection, disinfestation	8-30
Meat, poultry, fish	Disinfection, delays spoilage	1-10
Some fruits	Delays mold growth	1-4
Grain, fruits, vegetables	Disinfestation	0.01-1
Non-citrus fruits	Delays ripening	0.25-0.15
Pork	Controls trichina	0.08-0.15
Onions, garlic, potatoes	Prevents sprouting	0.05-0.15
Slide 5		

WHO USES FOOD IRRADIATION?		
Argentina	Germany	Philippines
Bangladesh	Hungary	Poland
Belgium	India	South Africa
Brazil	Indonesia	Spain
Bulgaria	Israel	Syria
Canada	Italy	Thailand Russia
Chile	Japan	United Kingdom
China	Korea	USA
Cuba	Mexico	Uruguay
Czechoslovakia	Netherlands	Vietnam
Denmark	New Zealand	Yugoslavia
Finland	Norway	
France	Pakistan	
Slide 6		

IRRADIATED PRODUCTS USED ON THE FIRST 24 SHUTTLE FLIGHTS
(1981 TO 1986, Approximately 805 Man-Days)

	Servings	
MEAT PRODUCTS	**Total Sent**	**Total Used**
Beef Steak	231	164
Corned Beef	41	11
Smoked Turkey	104	53
Total Meat	376	228
BAKERY PRODUCTS		
Bread (seedless rye)	172	64
Breakfast Rolls	81	57
TOTAL BAKERY	253	121

Slide 7

WHO APPROVES OF FOOD IRRADIATION?

World Health Organization

U.S. Food and Drug Administration

U.S. Department of Agriculture

U.S. Public Health Service

American Medical Association

Mayo Clinic

Food Technology Institute

Institute of Food Technologists

American Veterinary Medical Association

American Meat Institute

Kiplinger Agricultural Letter

Prevention Magazine

Slide 8