FOOD IRRADIATION – WHAT'S THE BIG DEAL?

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I. INTRODUCTION

What's the big deal about food irradiation? The big deal is food irradiation is a beneficial process that is not widely used to protect human health. According to a 1999 report from the Centers for Disease Control and Prevention (CDC)[1], pathogens through foodborne transmission cause 13.8 million illnesses, 60,854 hospitalizations and 1,809 deaths in the U.S. yearly. Irradiation can significantly reduce these statistics if used to control pathogens on high-risk foods, such as poultry, red meat, pork, and ready-to-eat foods, such as meats and salad greens.

Food irradiation is the process of briefly exposing food to a highly penetrating and controlled amount of ionizing radiation (energy) in the form of high-speed particles or rays.[2] The energy deeply penetrates food, targeting and killing live microorganisms that cause it to spoil, cause us to get sick or contaminate the food. It leaves behind no residues to make food radioactive, nor does it significantly change food's nutritional function or sensory quality. Irradiation provides several important benefits. It significantly reduces foodborne pathogens and bacteria, extends the shelf life of fruits and vegetables, decontaminates spices, herbs and dried vegetable seasonings, and controls harmful pests on fruits and vegetables to prevent pest importation.[3] Based on extensive, scientific evidence that verifies its safety and benefits, food irradiation is internationally supported.

This paper will discuss the safety and benefits that support using irradiation on

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[1] *See* Paul S. Mead et al., *Food Related Illnesses and Death in the United States,* Immerging Infectious Diseases, Vol. 5, No. 5, September-October 1999, 607 at 610-612, *available at* http://www.cdc.gov/ncidod/eid/vol5no5/pdf/mead.pdf, (last visited Feb. 23, 2007).

[2] *See* Institute of Food Science & Technology, The Use of Irradiation for Food Quality and Safety (Feb. 2006), at 2, *available at* http://www.ifst.org/uploadedfiles/cms/store/ATTACHMENTS/Irradiation.pdf (last visited Feb. 23, 2007).

[3] *See* United States General Accounting Office, GAO/RCED-00-217 (August 2000), at 14-16, *available at* http://www.gao.gov/new.items/rc00217.pdf (last visited Feb. 23, 2007).

high-risk foods to reduce illnesses and deaths caused by foodborne pathogens. Section II will provide background. Section III will review the process. Section IV will review consumer perception and labeling regulations.

II. BACKGROUND

Food irradiation is not a new technology. First interest was in 1896 in Germany,[4] and the first patents were issued in 1905 in the U.S. and the United Kingdom. This section will review U.S. history, safe dose approval and international applications.

A. U.S. History[5]

Scientists at the Massachusetts Institute of Technology were the first U.S. scientists to study irradiation (1899), and many additional studies were completed during the first half of the 20th century.[6] In 1921, a U.S. patent was granted for a process to kill Trichinella spiralis in pork with X-rays. The National Food Irradiation Program was formed in 1953, and for the next 27 years, the U.S. Army and the Atomic Energy Commission (AEC) sponsored many research projects. During the 1960's, the U.S. Army Medical Services completed studies using rats, mice and beagle dogs, testing 21 foods that represent all major food classes in American diets.[7]

Many significant events occurred in the last 40 years.[8] The Food, Drug and Cosmetic Act was amended in 1958 to include irradiation as a food additive. In 1963, the Food and Drug Administration (FDA) approved irradiation for insect control on wheat and flour, and in 1964, to inhibit sprouting in white potatoes. The U.S. Army and the AEC petitioned the FDA to approve food packaging irradiation from 1964 through 1968,

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[4] *See* Eileen M. Stewart, *Food Irradiation: More Pros Than Cons*, Biologist, 2004, at 91.

[5] *See* United States General Accounting Office, GAO/RCED-00-217 (August 2000) at 27. (providing a chronology of food irradiation events), *available at* http://www.gao.gov/new.items/rc00217.pdf (last visited Feb. 23, 2007).

[6] *See* James H. Steele, D.V.M., M.P.H., *Food Irradiation: A Public Health Measure Long Overdue!*, 21st Century Science and Technology Magazine, Fall 1999, at 24.

[7] *Id.*

[8] United States General Accounting Office, s*upra* note 3.

which resulted in FDA approval in 1971. In 1976, the U.S. Army contracted with commercial companies to study the wholesomeness of irradiated ham, pork and chicken. The U.S. Army's food irradiation program was inherited by the United States Department of Agriculture (USDA) in 1980. Then in 1985, the FDA and the USDA began expanding approval of irradiation to many other foods and packaging materials.

B. Safe Dose Approval

In 1980, the Joint FAO/IAEA/WHO[9] Expert Committee on the Wholesomeness of Irradiated Food (JECFI) determined foods irradiated with up to an overall average dose of 10 kiloGray (kGy) are wholesome and introduce no special nutritional or microbiology problems.[10] The WHO and FAO asked the International Committee on Food Microbiology and Hygiene of the International Union on Microbiological Societies for a second opinion on the microbiological safety. The process and dose were cleared in 1982 when the committee confirmed no microbiological hazards exist with doses up to 10 kGy.[11] Based on the JECFI's scientific judgment, the committee report and other scientific evidence, the FAO/WHO Codex Alimentarius adopted the Codex General Standard For Irradiated Foods in 1983, setting 10 kGy as the upper limit.[12] Endorsement by the FAO, IAEA and WHO and the adoption of the Codex standards recognized irradiation as a safe and effective food preservation method.

Most foods require low to medium dose irradiation (<10 kGy). However, some applications, such as spice disinfection and sterilization of packaged foods, require high doses (>10 kGy). A WHO Study Group met in Geneva (September 15-20, 1997) to determine if doses >10 kGy are safe, and if they cause insignificant nutritional or quality degradation. The objectives included 1) reviewing relevant data related to toxicological,

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[9] Food and Agricultural Organization, International Atomic Energy Agency, World Health Organization.

[10] *See* Joint FAO/WHO Food Standards Programme, *Report of the Fifteenth Session of the Joint FAO/WHO Codex Alimentarius Commission*, Alinorm 83/43 (September, 1983) (referencing *Wholesomeness of Irradiated Food,* WHO Technical Report Series No. 659, WHO, Geneva), *available at* http://www.fao.org/docrep/meeting/005/ac317e/AC317E03.htm#chIII.1.1, (last visited Mar. 26, 2007).

[11] *Id.* (referencing Codex document CX/FH 83/9).

[12] *Id.*

microbiological, nutritional, radiation chemical and physical aspects of foods irradiated at doses >10 kGy, 2) determining whether treated foods are wholesome, and 3) considering the need for a maximum dose.[13] Based on extensive scientific evidence, the Study Group concluded 1) at any dose required to achieve the technological objective, the food is wholesome, safe and nutritionally adequate, and there are no toxicological hazards or microbiological problems; 2) high dose food irradiation is similar to conventional thermal processing, such as canning; 3) there is no risk of causing hazards by formation of chemical or physical entities or creating radioactive foods, and 4) most applications will be below those that would compromise sensory quality, so no upper dose limit is needed.[14]

C. International Applications

After adoption of the Codex standard, 40 countries initiated regulations, allowing irradiation of 50 food commodities. As of February, 2006, more than 50 countries have approved irradiation on over 60 products.[15] Irradiation is used in Asia, Europe, Africa, South America and North America. The leaders include the U.S., the Netherlands, Thailand, South Africa and Europe.[16] Irradiation is used world wide on a variety of foods. Irradiated frogs' legs are sold in the Netherlands, Belgium, France and Finland. Irradiated fruit and cheese are sold in France. Irradiation is used to prevent sprouting on white potatoes in Japan and sweet potatoes in Hawaii. Herbs, spices and mangoes are irradiated in South Africa. For many countries exporting fruits and vegetables, using irradiation to control harmful pests can increase trade in world markets.

Since 1963, the FDA and the USDA have approved irradiation on many foods, such as wheat, flour, pork, fruits, vegetables, spices, poultry, red meat, eggs, sprouting

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[13] World Health Organization, Joint FAO/IAEA/WHO Study Group, High-Dose Irradiation: *Wholesomeness of Food Irradiated With Doses Above 10kGy*, WHO Technical Report Series 890 (1999) at 2-3, *available at* http://www.who.int/foodsafety/publications/fs_management/en/irrad.pdf (last visited Feb. 23, 2007).

[14] *Id.* at 48, 79, 161-162.

[15] *See* Institute of Food Science & Technology, *supra* note 2, at 1.

[16] *Id.*

seeds and shellfish. Approval is specific for each type of food, based on use or effect, and at maximum dosage levels, which are measured in kiloGray (kGy) or kilorad (krad).[17] Packaged foods may also be irradiated. However, the packaging materials must be approved and proven safe, so that when subjected to irradiation, no induced radioactivity is detectable in the packaging material itself.[18]

The International Consultative Group on Food Irradiation was established in 1984 to continue international coordination of food irradiation efforts and remained active through May, 2004. The Joint FAO/WHO Division of Nuclear Techniques in Food and Agriculture is currently responsible for coordinating and supporting research, "providing technical and advisory services, providing laboratory support and training, and collecting, analyzing and disseminating information".[19] The activities focus on strengthening Member State capacities regarding international application of food irradiation and capacity building to manage food and environmental hazards from farm to fork.[20]

Food irradiation has been studied for over 100 years and is the most extensively studied food preservation process.[21] Its safety at low and high doses has been verified, and its benefits are recognized world wide. It is endorsed by international organizations (WHO, FAO, IAEA and Codex Alimentarius), U.S. governmental agencies (FDA, USDA and CDC), many national health and scientific organizations (American Medical Association, American Dietetic Association, Institute of Food Technologists, and American Council for Agricultural Science and Technology), and over 50 governments. This level of support would not exist if food irradiation was not safe and beneficial.

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[17] *See* 21 C.F.R § 179.26 (2006)

[18] *See* 21 C.F.R. § 179.45 (2006)

[19] *See* http://www.iaea.org/programmes/nafa/d5/index.html (last visited Feb. 23, 2007).

[20] *Id.*

[21] Paisan Loaharnu, Irradiated Foods 5 (Food and Environmental Protection Section Joint FOA/IAEA Division, Vienna, Austria, American Council on Science and Health 5th ed. 2003) (1982), *available at* http://www.acsh.org/publications/pubID.198/pub_detail.asp (lasted visited Feb. 24, 2007).

III. FOOD IRRADIATION PROCESS

Irradiation effectively protects solid foods from foodborne diseases like pasteurization protects liquids.[22] This section will review the food irradiation process, some of its negative impacts and how they can minimized.

A. Process

The three forms of energy approved to irradiate food are gamma rays, electron beams and X-rays.[23] Gamma rays (cobalt-60 and cesium-137) and X-rays are high-energy electrons that can evenly penetrate thick foods. They are effective on large bulk packages, frozen foods and full pallets. Electron beams can only penetrate about one inch, so they are only effective on thin packages or foods' outer surfaces. Food irradiation is referred to as cold pasteurization, because the high-energy electrons can uniformly inactivate deoxyribonucleic acid (DNA) and microorganisms, without changing the basic nature of the treated food.[24] Irradiation slightly heats food, but not enough to cause significant changes in sensory quality or nutritional function.

Irradiation inactivates the cell's DNA, so it cannot replicate, and the organism dies. Irradiation effectively eliminates parasites and bacteria, which have large DNA targets, but does not effectively eliminate viruses (which have very small DNA) or prions (such as BSE), which do not have nucleic acid.[25] Low doses (<1 kGy) eliminate insects and parasites, delay ripening and inhibit sprouting (increasing shelf life). Medium doses (1-10 kGy) eliminate pathogens and bacteria. High doses (>10 kGy) kill microorganisms and insects in spices, and sterilize foods for consumption by astronauts and people with compromised immune systems.

Irradiation can inactivate 99.9% of common pathogens, including Salmonella species, *Listeria monocytogenes*, *Staphylococcus aureus*, *Campylobacter jejuni* and

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[22] *See* MORTIN SATIN, FOOD ALERT! THE ULTIMATE SOURCEBOOK FOR FOOD SAFETY 121 (Checkmark Books 1999) (1999).

[23] *See* 21 C.F.R. § 179.26 (2006).

[24] MORTIN SATIN, *supra* note 22. at 119.

[25] *See* Centers for Disease Control and Prevention, Food Irradiation, October 11, 2005, *available at* http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm#affectmicrobes (last visited 2/24/07).

E.coli 0157H7. The dose required to achieve 99.9% inactivation varies depending on the contamination level, the type of food and the conditions during irradiation. One source stated the dose required for raw meat and poultry ranges from 0.48 to 2.22 kGy at 5ºC.[26] Another source stated that the dose required for a 5-log reduction (99.9%) ranges from 1.5 to 3.5 kGy.[27] However, lower doses are effective when combined with other measures. A report published in the Journal of Food Science stated that when irradiation is combined with chlorination, doses ranging from 0.15 to 0.5 kGy significantly reduce microbes in fresh cut lettuce.[28] The approved dose for fresh produce is 1.0 kGy; however, a petition has been submitted requesting the FDA to increase the allowable dosage to the dose allowed for red meat, which is 4.5 kGy.[29]

Because irradiation does not inactivate all bacteria, safe handling practices are critical. Irradiated foods must be properly handled, kept refrigerated and completely cooked before consumption. Irradiation improves food safety but does not replace food hygiene and safety measures. GMPs, Hazard Analysis Critical Control Point (HACCP) programs and established requirements for assuring safe, wholesome and unadulterated foods should be in place from farm to table.[30] Similar to milk, which is tested and graded for cleanliness before pasteurization to confirm pasteurization effectiveness, food should be relatively clean to guarantee food irradiation effectiveness.[31]

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[26] *See* Donald W. Thayer, Ph.D., Irradiation *of Food-Helping to Ensure Food Safety, 350* NEW ENG. J. MED. 1811-1822 (2004).

[27] James R. Gorny et al., Food Safety, USDA Agricultural Research Service, *available at* http://www.ba.ars.usda.gov/hb66/024foodsafety.pdf *(last visited Mar. 31, 2007).*

[28] A. Prakash et al., *Effects of Low-dose Gamma Irradiation on the Shelf Life and Quality Characteristics of Cut Romaine Lettuce Packaged under Modified Atmosphere*, 65, JOURNAL OF FOOD SCIENCE, 549, 549 (2000)

[29] James R. Gorny et al., *supra* note 27.

[30] See 21 C.F.R. § 110 (2006); 21 U.S.C. § 342.

[31] *See* Food Irradiation, (Coordinating Center for Infectious Diseases/Division of Bacterial and Mycotic Diseases ed., 2005), *available at* http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm#replaceprevention *(last visited Feb. 23, 2007).*

B. Negative Impacts

Irradiation, like other processing and preservation methods, has some negative impacts. Irradiation increases manufacturing costs. According to the American Nuclear Society, the cost to build a commercial food irradiation plant is $4 -$10 million (U.S.), depending on factors such as size and processing capacity. [32] Contracted irradiation facilities provide a more cost effective option, but there are added handling and transportation costs, and existing facilities are not always logistically feasible for many manufacturers and processors. The cost to irradiate food ranges from $10 - $15/ton (low-dose) up to $100 - $250/ton (high-dose),[33] which equates to 1-25 cents per pound. Although irradiation increases manufacturing costs, the increase is minimal when compared to health care costs, impact of illnesses and loss of life.

Irradiation affects nutritional properties and causes negative sensory changes in some foods.[34] There is little change in fats, proteins, carbohydrates, amino acids, essential fatty acids, minerals and trace elements, and there is minimal vitamin loss at low doses. However, high doses cause reduction of some vitamins, similar to the reduction caused by thermal manufacturing processes. Low dose irradiation causes high fat foods to develop off-odors and flavors. High protein foods may also develop off-odors and flavors when irradiated under ambient conditions. The quality of some raw shell fish degrades, and live oysters may be damaged or killed.[35] Irradiation also causes quality degradation in some fruits, such as some citrus fruits, pears, cantaloupes and plums.[36] A study by the USDA's Agriculture Research Service found that using ionizing irradiation (1 kGy) on Romaine, Iceberg and Endive salad greens caused slight browning

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[32] The American Nuclear Society, Food: Benefits/Effects, *available at* http://www.aboutnuclear.org/view.cgi?fC=Food,Benefits_%5E_Effects (last visited Feb. 25, 2007).

[33] *Id*.

[34] Institute of Food Science & Technology, *supra* note 2, at 7-8, (discussing the affects of irradiation on food's nutritional function and organoleptic quality).

[35] *See* Centers for Disease Control and Prevention, Food Irradiation, October 11, 2005, *available at* http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm#whichfoods, (last visited Mar. 7, 2007).

[36] *See* O.P. Snyder and D.M. Poland, Food Irradiation Today (Hospitality Institute of Technology and Management), 1995, at 9, available *at* http://hi-tm.com/documents/Irrad.html (last visited Mar. 5, 2007).

but also had a benefit - 14% increase in antioxidant capacity after 8 days.[37]

All foods do not perform well after irradiation exposure; however, irradiating under specific conditions reduces or minimizes nutritional and sensory changes. Irradiating foods at cool temperatures, in a vacuum (without oxygen) and when dry minimizes vitamin loss, and irradiating foods under refrigeration or when frozen reduces or minimizes sensory changes.[38] When irradiated under specific conditions and at approved doses, irradiated foods look fresh, stay fresher longer and are safer than unprocessed foods.

Irradiation is an effective and safe food preservation process, and when applied under specific conditions, it causes minimal sensory and nutritional changes. Irradiation supplements GMPs, HACCP and other safety and quality programs already in place to assure foods are safe and wholesome, but irradiated foods should be properly washed, handled, refrigerated and cooked by consumers. Food irradiation is not necessary or appropriate for all foods. However, it can drastically reduce the risk of foodborne diseases if applied to poultry, red meat and pork, by eliminating >99% of common pathogens that cause most foodborne illnesses, hospitalizations and deaths.[39] If applied to ready-to-eat foods at levels needed for pathogen control or at low levels combined with other measures, irradiation can prevent recalls, such as the 2006 lettuce and spinach recalls, caused by deadly *E. coli* contamination.

IV. CONSUMER PERCEPTION AND LABELING REQUIREMENTS

Many consumers don't understand the benefits of food irradiation or its verified safety. However, studies show that after consumers understand the process, its safety and its benefits, most will purchase irradiated food. This section will review current

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[37] *See* Xeutong Fan, *Antioxidant Capacity of Fresh-Cut Vegetables Exposed to Ionizing Radiation*, Journal of the Science of Food and Agriculture, 85, January 26, 2005, 995-1000 *available at* http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=163532, (last visited Feb. 23, 2007).

[38] Institute of Food Science & Technology, *supra* note 2, at 7-8.

[39] *See* Paul S. Mead et al., *supra* note 1, at 607, 610-612, 616-622 (discussing pathogens causing most illnesses, hospitalizations and deaths yearly).

consumer perception and labeling requirements.

A. Consumer Perception

Consumers don't understand food irradiation; groups like Public Citizen create fear of irradiation and its effects on foods, and although widely approved, treated foods are not readily available for purchase. Some common questions have been addressed in this paper. Are foods radioactive? Is the nutritional quality compromised? Are manufacturers using irradiation to mask and market clean filth? Will the irradiated foods cost more? These questions are similar to those of milk pasteurization during the 1800's, caused by lack of understanding. Providing appropriate information about food irradiation, its benefits and its safety answers the questions and improves consumer acceptance.

Results of a 2003 study by Aiew, Nayga and Nichols[40] suggest that information explaining the nature and benefits of food irradiation is a major factor affecting consumers' perceptions, attitudes and willingness to pay for irradiated foods. The study was conducted to assess consumers' knowledge and acceptance, and the effects of information on consumers' acceptance and willingness to buy irradiated ground beef. Consumers were interviewed at grocery stores in four Texas cities and were provided two types of information. The first described food irradiation and its benefits, and the second described the difference in electron beams and gamma rays. Before information was provided, 45% had no knowledge of food irradiation; 51% would not buy irradiated ground beef, and only 8.5% were strong buyers. After information was provided, 94.12% were willing to buy irradiated ground beef; strong buyers increased to 42.23%, and 24% of the doubters and 41% of the rejecters switched to being strong buyers. Consumers willing to buy irradiated ground beef were also willing to pay more: 100% - 5 cents/lb, 97.3% - 10 cents/lb and 67% - 20 cents/lb.

A 1995-96 study by the Center for Consumer Research had similar results. After

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[40] *See* Wipon Aiew, Rodolfo M. Nayga, Jr. and John P. Nichols, *The Promise of Food Irradiation: Will Consumers Accept It?* Choices, Third Quarter 2003, at 31, *available at* http://www.choicesmagazine.org/2003-3/2003-3-06.htm, (last visited Feb. 23, 2007).

a 10 minute video describing irradiation, interest in buying irradiated foods among California and Indiana consumers increased from 57% to 82%.[41] The CDC also estimates at least 50% of consumers will buy irradiated food if given a choice, and when educated about irradiation and how it is used, the willingness to buy increases to 80%.[42] These and other studies indicate that providing consumers with the right information will cause positive consumer acceptance.

B. Labeling Regulations

With the passing of the Food Additives Amendment of 1958, Congress defined the radiation source as a food additive[43]. The regulations[44] define labeling requirements for irradiated foods that are packaged, bulk and will be further processed. Retail package labeling must bear the international food irradiation symbol, the Radura, and one of these statements: "treated with radiation" or "treated by irradiation". These requirements also apply to bulk food containers; however, the information may be on a counter sign, card or other appropriate device, obvious to the consumer, or bulk foods may be individually labeled. When foods are shipped to another location for further processing, labeling or packing, the label, labeling and invoices or bills of lading must bear one of these statements: "Treated with radiation—do not irradiate again" or "Treated by irradiation—do not irradiate again". These regulations have been debated by industry as causing consumer rejection, but the goal is to make irradiated foods easily identifiable.

Are consumers ready for irradiated foods? Without adequate information, many consumers have questions about irradiation. However, after being informed, consumer

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[41] *See* Christine M. Bruhn et al., Center for Consumer Research, Consumer Acceptance (2000), *available at* http://ccr.ucdavis.edu/irr/accept.shtml, (last visited Feb. 23, 2007).

[42] *See* Centers for Disease Control and Prevention, Food Irradiation, October 11, 2005, *available at* http://www.cdc.gov/ncidod/dbmd/diseaseinfo/foodirradiation.htm#consumers, (last visited Feb. 23, 2007).

[43] *See* George H. Pauli, U.S. Regulatory Requirements for Irradiating Foods (US FDA, Center for Food Safety & Applied Nutrition, Office of Premarket Approval), May, 1999, at 1, *available at* http://www.cfsan.fda.gov/%7Edms/opa-rdtk.html, (last visited Mar. 5, 2007).

[44] *See* 21 C.F.R § 179.26 (2006).

acceptance increases, and when provided a choice of foods treated by irradiation to reduce pathogens and other spoilage bacteria, many indicate positive purchase intent. Also, the labeling regulations allow easy identification of irradiated foods, so consumers can make informed purchasing decisions.

CONCLUSION

Extensive research proves food irradiation is safe and significantly reduces food pathogens, bacteria, molds, pests and insects, without significantly changing nutritional function or overall quality of many foods. Irradiation may slightly increase manufacturing costs, but these costs are minimal when compared to the cost of 13.8 million illnesses and 1,809 deaths in the U.S. yearly caused by foodborne pathogens.[45] Using irradiation can inactivate pathogens, such as *E. coli*, *Campylobacter* and *Salmonella* in red meat, poultry and pork, *Listeria* in deli meats and hot dogs, and *E. coli* in salad greens. Providing safer food options can provide a marketing edge for manufacturers, substantially increase sales, and reduce overall manufacturing costs by preventing recalls and negative impacts (reputation/brand image and litigation costs/damage awards). Irradiation can provide safer foods for consumers.

Irradiation is extremely beneficial but is not widely used on high-risk foods to reduce foodborne diseases and improve the safety of our food supply and consumer health. What are the obstacles? Manufacturers and processors are unwilling to increase their costs to use irradiation. Irradiation facilities are not widely available, cost effective or logistically feasible for many manufacturers. Consumers do not understand the benefits of purchasing irradiated food. What will remove the obstacles? FDA approval and endorsement for irradiation as pathogen control on ready-to-eat foods may help lead the way. More irradiation facilities or cost effective in-plant options may increase its use. Continued support and consumer education by government agencies and scientific bodies may increase its understanding and acceptance.

If consumers valued the positive impact irradiation could have on the food supply, they could drive wide-spread use on high-risk foods. Purchase decisions before

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[45] *See* Paul S. Mead et al, *supra* note 1, at 610, 612.

1980 were based on taste and price. Purchase decisions since the 1980's are based on health and nutrition. Now, with global exposure to and impact of foodborne illnesses and deaths, purchase decisions may be based on food safety. Food irradiation offers the same benefits as widespread use of pasteurization since 1966. If consumers want safe food, they must ask for food irradiation!