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Consumer Acceptance of Irradiated Meat and Poultry Products

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The Federal Government began allowing food manufacturers to irradiate raw meat and meat products to control pathogenic microorganisms in February 2000. Consumer acceptance of irradiated foods could affect public health because many foodborne illnesses occur when consumers handle or eat meat or poultry contaminated by microbial pathogens. However, food manufacturers have been slow to adopt irradiation, partly because of the perception that relatively few consumers are willing to buy irradiated foods. A recent survey by the Foodborne Diseases Active Surveillance Network (FoodNet) confirmed this perception: only half of the adult residents of the FoodNet sites were willing to buy irradiated ground beef or chicken, and only a fourth were willing to pay a premium for these products, which cost more to produce than comparable nonirradiated products. These findings suggest that the impact of food irradiation on public health will be limited unless consumer preferences change, perhaps in response to educational messages about the safety and benefits of food irradiation.

The potential market for irradiated foods expanded in February 2000 when the Federal Government added raw meat and meat products to the list of foods that can be irradiated to control pathogenic microorganisms. Food manufacturers are now permitted to irradiate beef, lamb, and other red meats as well as other approved foods (including poultry, pork, and spices) in order to reduce or eliminate potentially dangerous pathogens (see box, "Food Irradiation," p. 2). The U.S. Centers for Disease Control and Prevention (CDC) has estimated that foodborne pathogens are responsible for 76 million illnesses in the United States each year, resulting in 5,000 deaths (Mead et al., 1999).

Consumer acceptance of irradiated meat and poultry has important public health implications because irradiation can prevent foodborne illnesses that occur when consumers handle or eat meat or poultry contaminated by microbial pathogens (see box, "Foodborne Illness Due to Raw Meat and Poultry," p. 3). Although many food manufacturers are interested in using irradiation to control foodborne pathogens, a recent survey by CDC's Foodborne Diseases Active Surveillance Network (FoodNet) found that only half of consumers were willing to buy irradiated meat or poultry, and only a fourth were willing to pay a premium for such products, which are likely to cost more than comparable nonirradiated products. The low level of consumer demand suggests that the impact of food irradiation on public health will be limited unless more consumers decide that irradiation increases the safety and value of raw meat and poultry.

List of Foods Approved for Irradiation Has Expanded

The Federal Government first approved irradiation as a method for controlling foodborne pathogens in 1983, although the procedure was initially restricted to spices and dried vegetable seasonings. Approval for using irradiation for pathogen control was subsequently extended to dry enzyme preparations in 1985, to raw pork (for controlling *Trichinella spiralis* parasites) in 1986, and to raw poultry in 1992. The recent approval of irradiation for raw meat and meat products covers both refrigerated and frozen products. Temporary approval was also granted for irradiating prepackaged meat and poultry products using any of the

Food Irradiation

Commercial irradiation equipment uses gamma rays, electron beams, or X-rays to expose food products to ionizing radiation that causes changes at the molecular level, damaging or destroying living cells. Depending on the type of food and radiation dosage, irradiation can be used to sterilize food for storage at room temperature, control pathogenic microorganisms, delay spoilage of fresh foods, control insect infestations, delay ripening of certain fruits, or inhibit sprouting of certain vegetables. Extensive scientific research reviewed by the World Health Organization (WHO) and the U.S. Food and Drug Administration has indicated that irradiated food is safe to eat (WHO, 1994; U.S. Department of Health and Human Services, 1997).

packaging materials previously approved for gamma-ray irradiation. The Federal Government is currently considering whether to permit irradiation to control pathogens in ready-to-eat processed meats such as hot dogs and cold cuts, which may be contaminated by *Listeria monocytogenes*. *Listeria* can cause severe illness in pregnant women, the elderly, or other susceptible subpopulations. Irradiation has also been approved for several other purposes, including eliminating insect pests from foods, inhibiting the maturation of fresh foods, extending the shelf life of raw meat, and sterilizing medical devices, food packaging materials, and certain other consumer goods.

Although food manufacturers have been permitted to use irradiation to control pathogens in raw pork and poultry for some time, irradiated products account for only a tiny share of the estimated 51.4 billion pounds (boneless equivalent weight) of meat and poultry consumed in the United States in 1998 (Putnam and Allshouse, 1999). During the late 1990's, only four U.S. retail stores routinely offered irradiated food products for sale. Irradiated chicken is served in some hospitals and nursing homes because sick and elderly persons are more susceptible to foodborne pathogens than the general population. Several large food manufacturers that produce over 75 percent of U.S. ground beef and nearly 50 percent of U.S. poultry signed agreements with a commercial irradiation firm in 1999 to begin treating meat and poultry for test marketing (*Wall Street Transcript*, 2000). As of July 2000, one food manufacturer had begun marketing irradiated frozen beef patties in chain grocery stores in the Minneapolis-St. Paul area, while another had begun selling irradiated fresh ground beef in several independent grocery stores in Florida.

Equipment Costs and Consumer Concerns Limit Market

The small size of the irradiated foods market has been attributed to two factors, the high capital costs of irradiation equipment and the perception among food manufacturers that relatively few consumers are willing to buy irradiated foods. A number of different companies produce irradiation equipment, although most of the U.S. irradiation treatment market involves the sterilization of medical devices. The capital costs of irradiation equipment for meat and poultry plants depend primarily on the radiation source (gamma rays, electron beams, or X-rays), product characteristics, plant volume, and facility design (irradiation equipment can be installed in a stand-alone facility, an integrated unit attached to an existing plant, or an on-line unit incorporated directly into a plant production line). One recent study estimated that the capital costs of an electron beam system for a plant producing approximately 100 million pounds of product per year (about 0.1 percent of annual U.S. meat and poultry production measured by carcass weight) are about $4.4 million, depending on the exact specifications (Kaye and Turman, 1999). Another recent study estimated that the capital costs of a gamma ray or X-ray irradiation system for a larger plant producing approximately 220 million pounds of product per year range from $5.7 to $17.0 million, again depending on the specifications (Bogart and Tolstun, 1999). These estimates suggest that electron beam systems tend to be less expensive than gamma ray or X-ray systems. However, electron beams cannot penetrate food products more than three inches thick and have fewer potential applications in the meat and poultry industry than gamma rays or X-rays, which can penetrate an entire pallet load of food products.

Recent studies of the economic costs of irradiation equipment have not reported detailed information about operating costs. Earlier research by ERS found that the annual operating costs for a plant producing 100 million pounds of food products per year were $0.8 to $1.1 million for an electron beam system and $0.9 to $1.1 million (all in 1988 dollars) for a gamma-ray system (Morrison, 1989). The ERS study also found that there are substantial economies of scale involved in food irradiation based on gamma-ray or electron beam systems. Meat and poultry processing is highly concentrated in large

plants, favoring the adoption of irradiation technology because large plants can employ the most cost-effective irradiation systems. Nevertheless, food manufacturers have been reluctant to invest in integrated or on-line irradiation units. The companies that recently signed contracts to irradiate meat and poultry for test marketing agreed to ship products to a stand-alone contract irradiation unit rather than install irradiation equipment in their own plants. The use of contract irradiation services is advantageous for food manufacturers, who are currently uncertain about the magnitude of demand for irradiated meat or poultry. However, contract irradiation involves additional transportation and handling costs because product must be shipped to an intermediate destination to be irradiated before it is sold.

Although the capital costs of irradiation equipment are relatively high, the potential benefits of irradiating meat and poultry may also be quite large for food manufacturers. Properly operated irradiation units will reduce or eliminate the risk of pathogen contamination of food products and the possible adverse consequences for firms, including voluntary and mandatory product recalls, fines and other penalties for violating food safety regulations, litigation and damage awards resulting from foodborne illness, and the loss of business reputation and sales associated with unfavorable media attention. These costs may be substantial. For example, Hudson Foods, Inc., incurred over $24 million in special charges in 1997 after USDA ordered a recall of ground beef produced in one of the company's plants due to suspected *E. coli* O157:H7 contamination, including the costs of the recall and losses associated with the closure and subsequent sale of the plant. Hudson Foods was later sold to a competitor because of the potential negative impact of the recall on other company business operations (Securities and Exchange Commission, 1997).

Demand for irradiated meat and poultry depends on acceptance by the food service industry as well as by consumers. Food service companies could benefit by using irradiated meat and poultry because many outbreaks of foodborne illness have been traced to improper handling or inadequate cooking of raw meat or poultry by restaurants or other eating places, sometimes resulting in fines, damage awards, or other adverse consequences for the responsible firm. Although food service companies are not required to disclose whether prepared meals incorporate irradiated food products, only a few food service companies have used irradiated poultry or expressed interest in using irradiated meat. Decisions by food service companies to use irradiated meat and poultry could have a significant impact on demand because dining out has become increasingly popular in the United States, accounting for 27 percent of all meals and snacks in 1995 (Lin et al., 1999).

Most consumers have never seen irradiated meat or poultry in their local grocery store, so consumer acceptance of these products has yet to be tested on a large scale. Consumer surveys have typ-

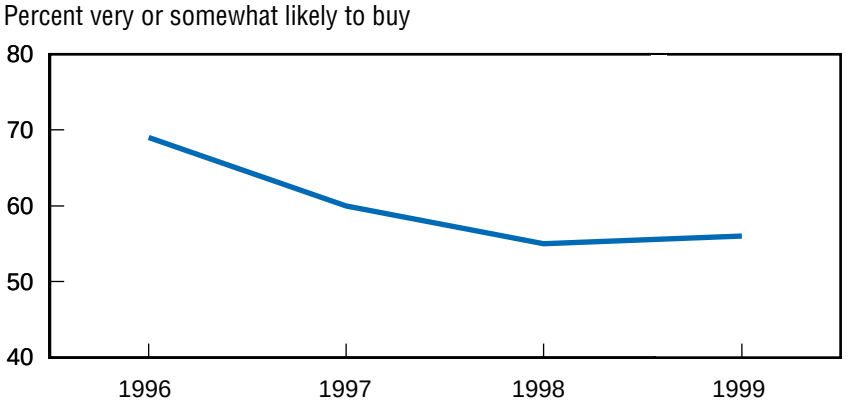
Foodborne Illness Due to Raw Meat and Poultry

The intestinal tracks of food animals are a natural habitat for some pathogenic microorganisms, including *E. coli* O157:H7, *Campylobacter*, and *Salmonella*. These pathogens may contaminate raw meat or poultry products during slaughter or processing, potentially causing human illness when the products are subsequently handled or eaten. Many consumers engage in food handling or consumption behaviors that increase the chances that contaminated meat or poultry will make them ill, including not adequately washing their hands or cutting boards after contact with raw meat or chicken and eating pink hamburgers that might be undercooked (Altekruse et al., 1999). However, the proportion of foodborne illnesses due to contaminated meat or poultry is not precisely known.

ERS reviewed the available information on foodborne illness due to contaminated meat and poultry when the Federal meat and poultry inspection system was revised in the mid-1990's (USDA, 1996). The analysis covered seven foodborne pathogens, and estimated that meat- or poultry-related infections were responsible for 50 percent of illnesses due to *Clostridium perfringens*, *Listeria monocytogenes*, and *Staphylococcus aureus*, 50-75 percent of illnesses due to *Salmonella*, 75 percent of illnesses due to *Campylobacter* and *E. coli* O157:H7, and 100 percent of illnesses due to *Toxoplasma gondii*. CDC has estimated that these seven pathogens are together responsible for 3.9 million foodborne illnesses and 1,600 deaths each year (Mead et al., 1999). Based on the ERS analysis, meat- and poultry-related infections account for 2.5 to 2.9 million illnesses and 1,000 to 1,200 deaths due to these seven pathogens. The total number of illnesses and deaths associated with meat or poultry is probably understated because 81 percent of the 76 million annual foodborne illnesses in the United States are due to unknown agents (Mead et al., 1999), and some of these illnesses may also be meat- or poultry-related. Furthermore, the ERS analysis excluded other pathogens that might be transmitted by meat or poultry, notably *Yersinia enterocolitica*.

Figure 1

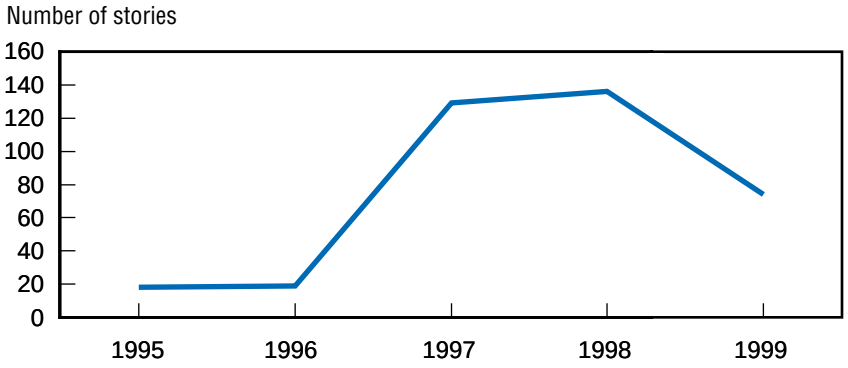
The proportion of supermarket shoppers who were likely to buy irradiated food products declined during the late 1990's



Source: Food Marketing Institute, 1996-99 annual surveys of consumer attitudes and the supermarket. Shoppers were asked how likely they were to buy foods that had been irradiated to kill germs and keep food safe.

Figure 2

TV news and newspaper stories about food irradiation increased markedly during the late 1990's



Source: Calculated by ERS based on archives for 4 national TV networks and 25 major newspapers published in 18 different States. Includes all stories mentioning "irradiation" in conjunction with food safety. Editorials and letters to the editor were excluded.

ically found that about 50 percent of respondents are willing to buy irradiated food, although the level of interest is higher when consumers are first informed that irradiation will control harmful bacteria. Annual surveys by the Food Marketing Institute indicate that the willingness of supermarket shoppers to buy irradiated food declined slightly during the late 1990's (fig. 1). During the same period there was a substantial increase in news stories about food irradiation (fig. 2), reflecting the initial stages of the approval process for irradiation of raw meat and the public debate over whether USDA's organic food standards should exclude irradiated foods. The decline in willingness to buy irradiated food suggests that the increase in news stories made some consumers more dubious about the safety or benefits of irradiated food.

Other surveys indicate that many consumers remain concerned about the safety of irradiated food despite their reported willingness to buy such products. For example, a national survey conducted by the Gallup Organization in 1993 found that over 60 percent of consumers were extremely concerned that irradiated food might be radioactive or capable of causing cancer or birth defects (American Meat Institute Foundation, 1993). Many consumers also opposed USDA's initial proposal in 1997 to allow certain irradiated foods to be labeled as "organic." The subsequent revision of the organic food standards to exclude irradiated products was based in part on 275,000 public comments provided to USDA, nearly all of which opposed the use of irradiation technology in organic production systems (USDA, 2000).

Price of Irradiated Food Also Matters

Irradiated food products cost more to produce than comparable nonirradiated products. The higher cost will reduce consumer demand for irradiated food products, depending on how willing consumers are to pay a premium for safer food. Recent studies have estimated that the current cost of irradiating meat or poultry is 0.5 to 1.5 cents per pound in a plant with an annual volume of 100 million pounds equipped with an electron beam system (Kaye and Turman, 1999), and 0.8 to 2.0 cents per pound in a larger plant with an annual volume of approximately 220 million pounds equipped with a gamma ray or X-ray system, depending on the assumed interest rate as well as the plant specifications (Bogart and Tolstun, 1999). USDA has estimated that the special labels for irradiated food products required

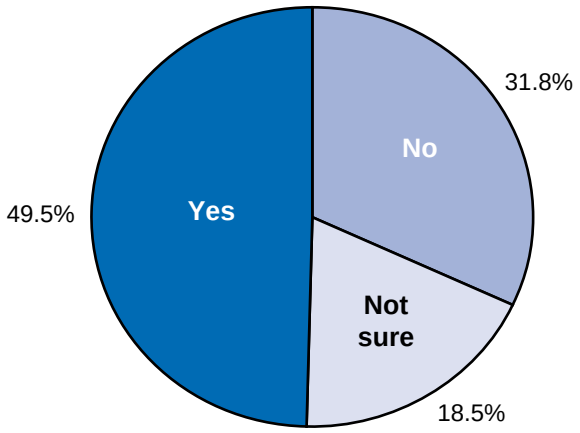
by the Federal Government will add another 0.2 cent per pound to the cost of irradiated ground beef (USDA, 1999). If food manufacturers elect to ship meat and poultry to stand-alone irradiation units rather than construct integrated or on-line irradiation units in slaughterhouses or processing plants, the additional costs of transportation will further widen the price differential between irradiated and nonirradiated products. USDA has conservatively estimated that transportation to stand-alone irradiation units will raise the cost of irradiated ground beef by an additional 0.2 cent per pound (USDA, 1999).

Food manufacturers are likely to pass on the additional costs of irradiated food products to consumers. Supermarket trials have demonstrated that consumers are sensitive to the price of irradiated foods. For example, a 1996 test that compared irradiated and nonirradiated chicken breasts found that the share of chicken breast sales that were irradiated products dropped from 43 percent when there was no price difference to 19 percent when there was a 10-percent premium for irradiated products (Fox and Olson, 1998).

The 1998-99 FoodNet Population Survey investigated consumer willingness to pay more for irradiated meat and poultry as well as other issues (see box "The 1998-99 FoodNet Population Survey," p. 7). Nearly 50 percent of adults in the sites covered by the survey were willing to buy irradiated meat or poultry, a level of acceptance similar to that found in earlier surveys (fig. 3). Other adults were either unwilling to buy these products (32 percent) or else were not sure (19 percent). Although half of adults were willing to buy irradiated meat or poultry, only 23 percent were willing to pay more for irradiated ground beef than they paid for nonirradiated ground beef, and only 25 percent were willing to pay more for irradiated chicken, a price response similar to that seen in supermarket trials (table 1). The FoodNet survey measures of consumer demand are not conclusive because questions about hypothetical purchase decisions may not be indicative of actual market behavior. Nevertheless, the survey results suggest that only a minority of consumers are likely to buy irradiated meat or poultry if it becomes readily available in retail stores but is priced higher than comparable nonirradiated products.

Figure 3

Only half of adult consumers in the FoodNet sites were willing to buy irradiated meat or poultry products in 1998-99



Source: 1998-99 FoodNet Population Survey.

Table 1

Consumer willingness to pay more for irradiated ground beef and chicken, FoodNet sites, 1998-99

Response	Ground beef	Chicken
	Percent	
Willing to buy irradiated meet or poultry:		
Would pay more	22.7	24.5
Wouldn't pay more	7.0	7.2
Not sure about paying more	17.5	16.5
Not willing to buy or unsure about buying irradiated meat or poultry	52.8[1]	51.9[2]
Total	100.0	100.0

[1]Includes 2.3 percent of respondents who were willing to buy irradiated meat or poultry but did not buy ground beef.
[2]Includes 1.4 percent of respondents who were willing to buy irradiated meat or poultry but did not buy chicken.
Source: 1998-99 FoodNet Population Survey. Totals may not sum to 100.0 percent due to rounding.

Consumer Education Could Play Role

Consumer reluctance to buy irradiated meat or poultry is due in part to a lack of information about food irradiation. The FoodNet survey found that only 48 percent of adults had ever heard of food irradiation, suggesting that public knowledge about irradiation is low despite the recent increase in news stories about it. Several studies have shown that consumers become more willing to buy irradiated foods after learning about the safety and benefits of irradiation. For example, a shopping study conducted by the University of Georgia in 1993 found that the proportion of consumers choosing irradiated over nonirradiated ground beef when there was no price difference rose from 52 to 71 percent after viewing a short audiovisual educational program (American Meat Institute Foundation, 1993). Findings of this kind suggest that consumer education programs could alleviate consumer concerns about irradiation and increase demand for irradiated foods.

The potential target groups for consumer education programs include consumers who are unwilling to buy or unsure about buying irradiated foods, as well as consumers who are unwilling to pay more or unsure about paying more for irradiated foods. The FoodNet survey found that these various groups account for about three-fourths of adults. Each group is likely to have different concerns that could be addressed by specific educational messages. According to the FoodNet survey, the most frequent reason why adults were unwilling to buy irradiated meat or poultry was insufficient information about food irradiation, followed by concern about the safety of eating irradiated food (table 2). Other reasons for not buying were much less common. The FoodNet survey did not investigate why some adults who were willing to buy irradiated meat or poultry would not pay more for these products, although it seems likely that they valued safer food less highly than individuals who were willing to pay more.

A broad-based effort to educate consumers about the safety and benefits of food irradiation has yet to emerge. In the absence of a major government or industry effort to educate consumers, public attitudes toward food irradiation might be shaped instead by the opponents of irradiation. Some observers believe that food manufacturers and food service companies were dissuaded from adopting food irradiation in the early 1990's after the Federal Government approved irradiation for poultry because of a national public campaign against food irradiation organized by an activist organization (Skerrett, 1997). Commercial interest in food irradiation appears to be stronger now than during the early 1990's due to heightened industry concerns about the adverse consequences of selling contaminated food, as well as the recent approval of irradiation for raw meat and meat products. However, many consumers might be susceptible to renewed efforts to raise doubts about the safety or benefits of irradiated foods. Accurate public information about food irradiation may well determine whether more consumers become willing to buy and pay more for irradiated food products, expanding the market for irradiated foods and almost certainly reducing the annual number of foodborne illnesses and deaths.

Table 2
Most important reason why adults would not buy irratiated meat or poultry, FoodNet sites, 1998-99

Most important reason	Percent
Insufficient information about risks and/or benefits	35.0
Concerned about safety of eating irradiated food	22.7
Irradiation doesn't make food safer	4.2
Doesn't eat meat or poultry	4.0
Concerned about environmental impact of irradiation	3.9
Doesn't need irradiation to make food safe	3.5
Doesn't like trying new foods/products	3.3
Price of irradiated food	2.5
Taste/appearance of irradiated food	1.4
Other, unspecified reasons	10.2
Doesn't know/not sure	7.9
Refused to answer	1.4
Total	100.0

Source: 1998-99 FoodNet Population Survey. Includes only those respondents (31.8 percent of total) who would not buy irradiated meat or poultry.

The 1998-99 FoodNet Population Survey

FoodNet is the principal foodborne disease component of CDC's Emerging Infections Program (EIP), and represents a collaborative effort by CDC, USDA's Food Safety and Inspection Service, the Food and Drug Administration, and the nine participating State health departments. FoodNet monitors foodborne illness and conducts an annual telephone survey of the population in each EIP site. The 1998-99 FoodNet population survey cited in this article covered seven sites (Connecticut, Georgia, Minnesota, Oregon, and selected counties in California, Maryland, and New York) including nearly 11 percent of the U.S. population. A total of 10,780 adults were interviewed. The topics addressed by the survey included food-handling behavior and current health status, as well as attitudes about food irradiation.

The first question about food irradiation on the 1998-99 FoodNet survey asked whether respondents had ever heard of "irradiation" as a process for treating food. After informing all respondents that irradiation is a process that reduces the number of bacteria and other microorganisms that might cause illness in improperly prepared foods, the next question asked whether respondents would buy meat or poultry that had been irradiated if it was available where they shopped. Respondents who would not buy irradiated meat or poultry were then asked to report the most important reason why they would not buy these products. Respondents who would buy irradiated meat or poultry were asked instead how much more per pound they would be willing to pay for ground beef and chicken that had been irradiated than they currently paid for comparable nonirradiated products.

The 1998-99 FoodNet population survey results were weighted to account for unequal probabilities of selection, based in part on Bureau of the Census population estimates for each site. The participating sites were not selected to provide a representative sample of the U.S. population, but are located in different regions and include both rural areas and urban centers. There is no evidence that attitudes toward food irradiation in the participating sites are likely to differ significantly from attitudes elsewhere in the United States.

More information about FoodNet and the members of the FoodNet Working Group is available from the FoodNet website at: http://www.cdc.gov/ncidod/dbmd/foodnet/

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