Consumer Attitudes and Market Response to Irradiated Food

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ABSTRACT

Results of consumer attitude and markets studies worldwide indicate consumers will accept irradiated food. Major studies in the United States indicate the number of consumers concerned about the safety of irradiated food has decreased in the last 10 years and continues to be less than the number of those concerned about pesticide residues, microbiological contamination, and other food-related concerns. The number of people reporting no concern about irradiated food is among the lowest for food issues, comparable to that of people with no concern about food additives and preservatives. Numerous studies have demonstrated that acceptance increases when consumers are provided with information about specific advantages of the irradiation process. Consumers view irradiated meat and poultry products positively, with half or more interested in purchase. Concern about irradiation centers around safety, nutritional quality, potential harm to employees, and potential danger from living near an irradiation facility. Women, people with lower incomes, and those with less formal education are more likely to express concern. Marketing of irradiated food in the United States, although limited, has been successful. Irradiated foods marketed in numerous countries were judged superior by consumers and sold well. These studies indicate that the market potential for irradiated food is strong. Consumers should receive information about irradiation advantages and environmental and worker safeguards.

Key words: Food irradiation, consumers, acceptance, food irradiation, consumer attitudes

Irradiation of food offers advantages to the processor, retailer and consumer. At low doses, it delays senescence of fruits and vegetables and is an effective quarantine treatment; higher doses "pasteurize" meat, and seafood; still higher doses substitute for fumigants used to sterilize spices and dried vegetables (25, 49). Despite these advantages, irradiation is not widely used because of uncertainty regarding consumer acceptance.

Although food irradiation has been studied since the 1950s, to the lay person it is a new technology. It is not unusual to express concern about technologies that are new. Even after more than 10 years of use, food technologies such as freeze-drying, freezing and microwaving generated major concern among a small percentage of consumers (37). Some persons are highly risk-averse. Therefore, one should expect that some consumers will express concern about the "new" technology of irradiation. Although irradiation is frequently described as "controversial," research in the United States and elsewhere indicate that when presented with information, acceptance is high. This paper reviews research on consumer attitudes and market response to irradiated food.

CONSUMER CONCERN

Studies in the 1980s indicated that consumers were unfamiliar with food irradiation. Researchers recommended that consumers receive information about the process and be offered a choice of irradiated and nonirradiated foods in the marketplace (1,16,50). Information about food irradiation has led to a positive view by the public and health professionals. After interviewing 26 groups of women totaling 195 individuals, Bord and O'Connor (13) concluded that the extent to which the public accepts or rejects irradiated food depends on the presence or absence of information. Others found those who knew something about irradiation and responded correctly to information about the technology were significantly more accepting of it when consumer preference for irradiation and chemical treatments were compared (30). A 1988 survey of professional home economists revealed that few knew the facts about irradiation (32); however, viewing a 90-min teleconference significantly increased knowledge and acceptance.

In the late 1980s and 1990s, universities, professional societies and industry groups have included irradiation in their public-information programs and information is slowly reaching the public. Coverage by the media, the primary source of consumer information, has frequently focused on special-interest groups who oppose irradiation. More recently, however, noteworthy pieces of investigative reporting, such as the 20/20 program on the ABC television network, have aired and the public has received accurate information regarding this topic. An article in Today's Health condensed in Reader's Digest (July 1993) and articles in women's magazines have increased public access to information.

The most recent nationwide consumer survey in the United States indicates that concern about irradiation is less than that for other food-related concerns (11). Additionally, the percentage concerned has decreased in the last two years.
years, probably due to increased science-based media coverage of this technology. When potential food-related hazards are specifically identified, 79% of consumers classify pesticide and herbicide residues as serious hazards, 55% place antibiotics and hormones in poultry and livestock in this category, and 35% consider nitrates in food and irradiated foods as serious hazards. The percentage classifying irradiated foods as a serious hazard has remained at 35% for 2 years, a seven-percent reduction from the 1989 through 1991 level of 42%.

The number of people expressing no concern about irradiated foods has increased. Ten percent responded that irradiated foods were not a hazard in a recent national survey (11). The only category which received a higher confidence level was artificial coloring with 26% believing it is not a hazard. Another nationwide survey reached the conclusion that 22% of consumers believed irradiated foods are not a hazard, even though the question suggested a hazard by asking, “What concerns do you have with buying irradiated fresh produce?” (9).

Similarly, a recent study in Georgia (n = 446) found consumer concerns for pesticides, animal drug residues, growth hormones, food additives and bacteria were significantly higher than concern for irradiation (43). Concern ratings for irradiation and naturally occurring toxins were comparable. More persons believed irradiation was no more a problem than other potential food safety issues such as food additives, growth hormones, animal drugs and pesticides: 20% for irradiation compared to 11%, 8%, 7% and 7% for the others.

Many consumers still have not formed an opinion about irradiation and are seeking additional information (9,11,41,43). In 1993, 72% had heard of irradiation, although 88% of those said they did not know very much about the process and 30% thought that irradiated food was radioactive (43).

When asked specifically about irradiation, people expressed concern about safety, nutritional quality, potential harm to employees, and potential danger from living near an irradiation facility. These concerns appear to be derived from the association of irradiation with radioactivity and nuclear power plants.

Consumer studies consistently demonstrate that, when provided with science-based information, a high percentage of consumers are willing to buy and prefer irradiated foods (17,19). A recent study conducted at Purdue University was undertaken to observe the effects of information and product samples on consumer attitudes (39). About half of the sample of 178 residents were willing to buy irradiated foods based upon previous exposure to information about the process. After viewing a brief video, subjects demonstrated a significant positive change in knowledge and willingness to buy increased to 90%. Among those who saw both the video and sampled irradiated strawberries, willingness to buy increased to 99%. These results cannot be generalized to the entire population, since a university community may have a disproportional number of people with more formal education; nevertheless, this study demonstrates high acceptance among specific segments of the population.

CHARACTERISTICS OF ACCEPTORS AND REJECTERS

Adoption of new technologies is led by innovators. Early users of new technologies are often of higher income, display a higher level of living, have a more prestigious occupation, and possess a more positive self-identity (44). They also have a greater ability to deal with abstractions, greater rationality, higher intelligence scores, are more favorable toward change, and can cope better with uncertainty. Science literacy plays a significant role in greater acceptance of nuclear power and probably also influences acceptance of irradiated food. Those who viewed nuclear power positively were more likely to have education in the sciences as opposed to the humanities, to read the newspaper frequently, and to include science-related television programs in their leisure activities (31).

Although the majority of people respond positively to information about food irradiation, a minority oppose the technology. Those opposed to food irradiation, estimated at 5%-10% of the population, are highly concerned about the use of chemicals on food, place a high value on an "ecologically balanced world," oppose the use of nuclear technology, and prefer to eat only unprocessed or "organic" food (2,16,18).

Demographic factors have been related to views toward irradiation. Women are more concerned about all issues that may affect food safety, including irradiation (7,10,11,47,48). People with formal education at the high school level and above are more likely to purchase irradiated foods (43,48). Before receiving information, blacks were not as likely as whites to purchase irradiated produce at lower or identical prices, although they were equally likely at higher prices (46). After learning more about irradiation, whites were more likely to purchase at any price. Introductions of products in California, Florida, Illinois and Missouri found good acceptance in upscale markets (15,35,41,42,46,48).

PRODUCT BENEFITS

Attitude studies demonstrate that label statements can serve as a source of information. Schutz, Bruhn, and Diaz-Knauf (45) measured consumer response to several label statements. Almost two-thirds of consumers considered products bearing the label statement "Irradiated to extend shelf life" or "Irradiated to retard spoilage" to be fresher than nonirradiated products, 22% were uncertain, and less than 4% thought the food would not store well. Products bearing the label "Irradiated to control microbes" were thought to be safer than nonirradiated products by almost 42% of the sample, with 28% uncertain, and only 14% thinking that safety would be lower. Thirty-six percent of consumers also thought products with this label would be higher quality, 25% did not know, and 12% believed that quality would be lower. About half of consumers expected irradiated products to be more expensive, with 5% to 10% saying less, depending on the label statement. The label having the lowest impact was "Irradiated for quarantine control"; however, 42% were more willing to buy this
product, with 23% being uncertain. All statements increased consumer interest in purchase, with the label "Irradiated to control microorganisms" generating the greatest interest.

Consumers also responded positively to the benefits of irradiation applied to specific products. Fifty-four percent were interested in purchasing irradiated tropical fruit, and 43% irradiated soft fruits (45). A majority of consumers preferred irradiated to nonirradiated pork and poultry (responses were 57% and 58%, respectively). Additionally, 58% preferred irradiated to fumigated spices. Uncertain consumers made up the next largest category; 17% to 36% checked this response.

Similar positive responses to irradiated foods were found in a study in Georgia (43). About half of the consumers expressed an interest in buying irradiated pork and poultry, with 27% and 34% respectively expressing uncertainty. Thirteen percent to 18% indicated they would buy more of these products if they were irradiated and properly labeled. Half of the consumers believed irradiation of fruits and vegetables was not necessary; however, 40% or more believed irradiation of pork, poultry, and seafood was "very necessary." Correspondingly, a nationwide survey found two-thirds or more of consumers believed irradiation was "very" or "somewhat necessary" for poultry, pork, beef and seafood (10). After hearing that scientific and health groups have endorsed the safety of irradiated foods, half preferred irradiated over nonirradiated meat.

Irradiated strawberries were rated comparable or superior to nonirradiated berries by Missouri consumers (48). Baskets of irradiated and nonirradiated strawberries were given to consumers in malls and supermarkets in the Kansas City, Missouri area. Some packages included educational information about irradiation whereas some did not. Consumers were asked to taste the strawberries as they normally would, then return a questionnaire. About 400 questionnaires were returned. People considered irradiated strawberries either comparable or superior in appearance and color to nonirradiated berries. Irradiated berries ranked well in freshness and firmness, with little difference in taste. Information about irradiation increased people's willingness to buy, both at equal prices and at a small premium. People were more willing to pay higher prices for irradiated berries when fact sheets about the process were included in the samples. In total, 80% of consumers reported they were pleased with irradiated strawberries; 67% were pleased with the nonirradiated berries. Half the consumers felt their supermarket should offer irradiated strawberries, about a third were uncertain, and 14% felt irradiated strawberries should not be featured in their supermarket.

A recent study used an auction technique to investigate consumer reaction to the benefits of irradiating pork (29). After auctioning a variety of products, students were given sandwiches made with irradiated or nonirradiated pork and were offered the opportunity to bid up for the product they did not have. The study indicated a very high level of acceptability for irradiated pork in a sample of 58 undergraduate students. Twenty-six of 29 subjects paid a premium for irradiated pork in order to reduce the risk of contracting trichinosis. Only one of 29 students paid to avoid the irradiated product based on an aversion to the irradiation process.

**INFLUENCE OF PRICE**

Economic analysis indicates that price influences willingness to buy. Whereas lower income groups were sensitive to price, the higher income groups were likely to purchase irradiated food at lower, identical, or higher prices (46,47). Attitude studies demonstrate that over half of consumers expect and are willing to pay more for irradiated foods (10,43,45).

**MARKET EXPERIENCES**

Consumer response to labeled irradiated food has been positive. Irradiated mangos sold well in Florida in 1986. In March 1987, irradiated Hawaiian papayas were available as a one-day trial at two markets in Southern California (15). Consumers could taste both the irradiated papaya and the traditional papaya. Leaflets were available explaining irradiation and knowledgeable persons were present to respond to questions. Interest in purchasing irradiated fruits in the future was high in both markets, 66% and 80%. Irradiated papayas outsold the identically priced nonirradiated counterparts by more than 10 to one. Additionally, irradiated apples marketed in Missouri were favorably received (48).

A record amount of irradiated strawberries was sold in a Florida produce market in the winter of 1992. On the first day of sales, 600 pints of irradiated berries priced at $2.00 each were sold compared to 450 pints of nonirradiated berries priced at $1.29. When prices were equal, the two berries sold equally. When irradiated berries were cheaper, they sold at a higher rate than the nonirradiated fruit. Consumers who did not find the berries too expensive, who trusted their retailer, distrusted activists, were more knowledgeable, and/or trusted health and scientific authorities were very likely to buy the irradiated strawberries (35).

In March of 1992, Carrot Top, a produce and grocery store in the Chicago area, featured irradiated strawberries, grapefruit, and juice oranges (41). Owner James Corrigan, in a newsletter survey of his customers, found that about 70% of his customers had heard about irradiation, but 90% felt that they had not received enough information. After investigating the process himself, he shared information with his customers via the newsletter and made both print and anti-material available at the point of sale.

Carrot Top sold 1,200 pints of strawberries, with approximately 90%-95% of them irradiated. The nonirradiated and irradiated berries were at the same price with a "buy one, get the other free" promotion. Corrigan had thought people would choose one of each and compare, but instead customers took both irradiated pints. Over the first weekend, he sold 172 cases of irradiated berries compared to only 6 cases of the nonirradiated. Grapefruit and juice oranges also sold well, with about 90% irradiated and 10% nonirradiated. Carrot Top has featured a variety of irradiated produce with similar sales success. In his second year of operation, Corrigan records that irradiated produce is outselling the nonirradiated by 20 to 1 [(Comments at
Safeguarding the Food Supply, October 1992, Orlando, FL). Irradiated poultry available in select markets has sold well. A Chicago produce market that had never offered produce before experienced brisk sales. Irradiated poultry represented about 10% of total poultry sales in a Florida supermarket, even though the irradiated poultry was more expensive and prepackaged whereas nonirradiated poultry was unpacked in a refrigerated case.

Great Britain

Consumers in Great Britain appear lacking in knowledge about irradiation and few are interested in purchasing irradiated foods. Interviews with 198 shoppers in Manchester and Salford shortly after the Chernobyl nuclear power accident found 12% of consumers were prepared to buy irradiated foods, while 70% said they would not buy them (28). People under 25 years of age and women were most negative about the technology. Concern about health risks, including cancer, was the most prevalent reason for unwillingness to purchase irradiated food. Concern about nutrient value and general lack of information about the process was also expressed. Although educational attainment was related to knowledge about irradiation, there was no clear relationship between more knowledge and greater or lesser willingness to buy irradiated foods.

To further explore the relationship between knowledge and acceptance, consumers were asked about several common food terms, such as pasteurization, freeze-dried and vacuum-packed. People recognized the names of many food terms; however, no more than 63% knew their meaning. The authors noted that if a term was familiar, the consumer tended to accept it unquestioningly and was unconcerned about the process. The authors concluded that an educational program about irradiation is essential so people can make an informed choice.

In 1989, a survey conducted for the Association for Consumer Research found half of the people interviewed had not heard of food irradiation, fewer than one in five agreed that food irradiation prevents food poisoning, and over half of the people thought that irradiation should not be permitted in the U.K. (5). People wanted irradiated food labeled and they indicated they preferred conventional food preservation methods.

In a summary of research in Great Britain, P. A. Thomas at the University of Bradford noted that public knowledge of the process of irradiation has changed little from 1986 to 1988. Thomas believes the public must be assured that irradiated foods are safe and that the irradiation process is monitored for safety.

The Netherlands

Consumer attitudes in the Netherlands have progressed from concern to acceptance of irradiation. In the early 1980s a small group of Dutch women were found to be very concerned about irradiation; however, when informed about the process, the women viewed its potential benefits favorably (24).

A questionnaire distributed to a panel of 1,158 found the percentage concerned about improperly processed foods and the use of irradiation were comparable (both at 26%), with slightly fewer concerned about pesticides and preservatives (21). Both concerned and less concerned consumers were most receptive to information that supported their point of view. Very concerned people were responsive to arguments that irradiated food is more hygienic. More extensive information about irradiation did not appear to lessen concern about the process; however, it increased sensitivity to the potential hazards of other food-handling methods. All consumers were given mushrooms, which they were told were irradiated. Actually, half of the consumers received irradiated and half nonirradiated mushrooms. Irradiation improved product quality to a degree recognized by the consumers. The mushrooms that were irradiated were judged significantly better by both the very concerned and the unconcerned consumers. Since the very concerned group was more sensitive to arguments that food becomes safer through irradiation, the authors concluded that concern may be more related to technical issues, such as fate of radioactive waste, rather than the food itself.

A 1992 survey of 1,200 households indicated that the number of Dutch consumers expressing a positive attitude toward irradiated foods had increased (6). When respondents were asked to choose between three different methods of preservation, heating, irradiation and preservatives, people preferred heating. Irradiation was preferred to preservatives, particularly among those with more formal education. When asked to interpret the meaning of irradiation, responses were varied, but the most frequent response, given by 25% of the respondents, was "good/excellent/positive." One-third or more of consumers were interested in buying irradiated products, with interest highest among those with the most education. If the whole produce item was irradiated, one-third said they would buy it, one-third would not buy, and the rest were uncertain. If the product contained irradiated ingredients, the percentage of respondents who would buy was slightly greater than those who would not. When it was stated that irradiated products have been on the market for some time and are permitted by the authorities, an accurate description in the Netherlands, 48% said they would definitely/probably purchase irradiated foods and 23% would not. Interest in purchase was 53% among those in the higher education group.

France

In the early 1980s, the French Higher Council for Public Hygiene and the Academy of Medicine accepted expert committee recommendations that food irradiation posed no toxicological or nutritional hazard (14). Subsequent test-marketing of irradiated food was successful. Two tons of irradiated strawberries, packed in covered plastic trays labeled "protected by ionization" and priced 30% higher than the nonirradiated product, sold well in May and June, 1987, in Lyon, France (3).

It is estimated that nearly 14,000 tons of various food items were irradiated in France in 1991. About 40% of these were spices, followed by dried fruit and vegetables and deboned poultry meat (14).
Italy

Potatoes labeled "Irradiated for the purpose of preventing sprouting" were successfully marketed in 1976 in Bologna, Milan, Rome and Pescara (12). Those who purchased potatoes returned a postcard indicating their preference for the irradiated potatoes because quality and storability were better.

Poland

Irradiated onions and potatoes sold well in market tests in two Polish cities (27). Four tons of onions and 3 tons of potatoes were stored in uncontrolled conditions for 9 months prior to sale. Ninety-seven percent of the consumers responding to a survey evaluated the products positively and indicated a desire to buy them again.

China

Numerous irradiated foods have been market tested in China (8). Ten tons of irradiated apples sold in Shanghai in January 1992. Consumers purchasing the irradiated apples received a leaflet explaining irradiation and a consumer acceptance form. Over 1,000 forms were returned. Consumer acceptance was high with 84% finding quality and flavor acceptable. Ninety-three percent of consumers said they would purchase the produce again, and food irradiation should be further developed.

The Chengdu people's market and department stores have conducted continuous market testing of garlic, ginger, hot pepper and meat products with over 3,000 consumer evaluation forms completed. Consumer acceptance averaged 70% with students at a high of 74% and office workers recording 68%. Willingness to buy ranged from 68% for hot peppers to 72% for ginger.

In 1991–92 over 200 tons of seasonings and meat products and 2,500 tons of irradiated sweet-potato wine were supplied to ten cities for test marketing. The products sold well, but no mention was made of consumer surveys.

Thailand

In the mid-1980s 160 tons of irradiated onions were sold at the rate of 4–10 tons per day at 14 shops (38). Consumers readily purchased irradiated onions even at a slightly higher price than the nonirradiated ones.

Nham, a fermented pork sausage consumed raw in Thailand, is often contaminated by Salmonella spp. and occasionally by Trichinella spiralis (40). In 1986, labeled irradiated nham was sold side-by-side with the traditional product. A consumer survey (n = 138) showed that 34% of the buyers selected irradiated nham out of curiosity and 66% considered that it was less likely to contain harmful microorganisms. Satisfaction with the product was high, as 95% of the consumers indicated they would purchase the irradiated products. A minority of customers, three in three years, refused to buy the product, saying it may cause cancer. Sales of irradiated onions ranged from 29% to 71% higher than nonirradiated, depending on variety. The authors concluded that irradiation permitted the grower to reduce losses by 32%, shipper by 47%, and retailers by 54%.

Pakistan

One ton each of irradiated potatoes and onions were test marketed at a provincial fruit and vegetable show in January and February, 1991 (33). Only 15% of the 300 consumers who completed a survey form were aware of food irradiation and fewer still, 11%, knew that irradiation of potatoes, onions, and spices was permitted in Pakistan. A high proportion, 70%, had doubts about the safety of irradiated foods; however, after seeing the display at the fruit and vegetable show, 69% indicated their concerns were resolved, 11% still had concerns, and 20% were uncertain. Thirty-nine percent said they were willing to buy irradiated food and convince others to buy, and 57% thought food irradiation should be commercialized.

Bangladesh

Irradiated dried fish and onions were marketed through normal channels every 15 days from September through January (36). Fish were labeled "disinfected by gamma radiation" and onions were labeled "irradiated to prevent sprouting." Consumers preferred the irradiated products.

Argentina

Irradiated onions and garlic were sold in a supermarket in the Buenos Aires area in 1985. Prior to the first marketing, consumers were told about food irradiation on the local TV, radio and in the press. Within 3 days of marketing, the entire 10 tons of irradiated product were sold (22,23). Consumers indicated product quality was the primary reason for purchase. In later years, irradiated onions continued...
to sell well (51). The investigators concluded that an education campaign and endorsement by the Ministry were keys for acceptance by consumers. They predicted significant opportunities for irradiation of onions and other foods.

**South Africa**

An extensive marketing and educational program was conducted in South Africa prior to the introduction of irradiated foods (52). In 1978 and 1979, 20 supermarkets sold labeled irradiated products, including 13 tons of potatoes, 20 tons of mangoes, 20 tons of papayas, and 7 tons of strawberries. The irradiated products were judged acceptable by 90% of buyers. Subsequently, researchers experimented with novel convenience foods processed through food irradiation (26). Approximately 200 members of the Defense Force tested the products and showed an overwhelming preference for the irradiated product over freeze-dried and canned counterparts.

**Other countries**

Additional market trials which took place in Bangladesh, Cuba, Germany, Indonesia and Yugoslavia are summarized in the Food Irradiation Newsletter (4). There is no doubt that consumers will accept irradiated foods when given science-based information about the process and when the irradiated product offers clear advantages.

**CONCLUSIONS**

Recognized health authorities in numerous countries consider irradiated foods safe and wholesome. The potential health benefits from this technology are substantial. Food-borne illness can be reduced by enhancing the sanitary quality of a product and by reducing the potential for cross-contamination in the home or food-service establishment. Since children under 5 years of age are most severely affected by microbiological pathogens, the moral obligation to increase protection is strong. Irradiation's potential to replace less safe chemical fumigants while maintaining food safety is also compelling.

The public's knowledge of food-processing methods in general and food irradiation in particular is very limited. Although accurate science-based information about food irradiation is now reaching consumers in the United States, there is still a long way to go, and the level of public knowledge in other countries is extremely low. If health professionals present accurate information about irradiation to the public, acceptance of the technology will likely increase. The potential for irradiation to increase the hygienic level of food could be realized.

**REFERENCES**


