

Influences on Purchase of Irradiated Foods

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Abstract

This article reviews data from surveys and retail experiments that examine the purchase decision between irradiated and non-irradiated (typical) products. The primary factor influencing purchase decisions is information provided about irradiation. Other factors include effectiveness of alternative technologies, gender, and the presence of children in the household. Female parents of younger children are less likely to choose irradiated foods.

Most people are still unfamiliar with the concept of food irradiation. Frenzen et al. (2001) found that only 48% of a sample of 10,780 adults had heard of the process. It seems reasonable then to presume that when consumers are asked about their willingness to purchase irradiated foods, the information provided about irradiation will affect the outcome.

The positive effect of additional information about the process has been demonstrated. For example, in a simulated market study in Georgia, the proportion choosing irradiated ground beef increased from 44% to 71% after information about the irradiation process was provided. Three other studies (Pohlman et al., 1994; Schutz, 1994; Bruhn and Mason, 1996) demonstrated the positive impact on attitudes of a short videotape presentation about irradiation.

However, because of space and time constraints, mail surveys and especially telephone surveys can only provide limited information. Data in Table 1 suggest that higher rates of acceptability are found in controlled retail studies, where more information can be provided. But a second, and potentially more important, consideration in interpreting study results is that when any information is provided, it invariably tends to be favorable to irradiation. Demonstrations and campaigns by irradiation opponents suggest that the information environment for new irradiated foods will feature both positive and negative information about the process, and thus survey results may provide misleading information about potential market success.

Effect of Unfavorable Information

Fox et al. (2002) describe how consumers respond to the presence of unfavorable information about food irradiation. In a choice experiment with consumers, 87 participants were given typical pork and asked to bid in a repeated auction for an upgrade to irradiated pork. Participants were required to consume either typical or the irradiated pork at the end of the experiment, and the auction was non-hypothetical—i.e., the winner was required to pay for the upgrade to the irradiated pork. For the first five of a total of ten rounds in the auction, participants were provided with the following description of irradiation:

The U.S. Food and Drug Administration (FDA) has recently approved the use of ionizing radiation to control *Trichinella* in pork products and *Salmonella* in poultry. Based on its evaluation of several toxicity studies, the FDA concluded that irradiation of food products at approved levels did not present a toxicological hazard to consumers nor did it

adversely effect the nutritional value of the product.

Irradiation of pork products at approved levels results in a 10,000 fold reduction in the viability of *Trichinella* organisms present in the meat.

The forms of ionizing energy used in food processing include gamma rays, x-rays, and accelerated electrons. Ionizing energy works by breaking chemical bonds in organic molecules. When a sufficient number of critical bonds are split in the bacteria and other pests in food, the organisms are killed. The energy levels of the gamma rays, accelerated electrons, and x-rays legally permitted for processing food do not induce measurable radioactivity in food.

This description is based on a review of the scientific literature on food irradiation.

Based on this description, approximately 60% of participants bid some amount to upgrade from typical to irradiated pork. Participants were then provided with either a favorable or unfavorable description of irradiation or both simultaneously. The favorable description (from the American Council on Science and Health) emphasized the benefits and safety of the process and its contribution to controlling foodborne illness. The unfavorable description (from Food & Water, Inc.) noted that irradiation produced carcinogens called radiolytic products, that it caused vitamin losses, that it would eliminate warning signs of botulin toxin, and that the use of radioactive materials would put workers and nearby communities at risk.

As expected, the favorable description alone resulted in more bids to upgrade to irradiated pork and the unfavorable description alone caused bids to decrease. Given only the favorable description, close to 90% bid for the upgrade to the irradiated product. Given only the unfavorable description, the proportion bidding for irradiated pork fell from 60% to 10–15%. But the disappointing result is that when subjects were provided with both sets of information, the effect of negative information dominated that of the positive and the proportion bidding for irradiated pork fell by approximately 20 percentage points. In fact, of 50 subjects who received both descriptions, only one subsequently submitted a higher bid to obtain irradiated pork.

When subjects were asked which “piece of information” was most important in causing them to reduce their bid, the most damaging factor was the opponent’s claim of a link between irradiated food and increased cancer risk. Thus, even if processors use only electron-beam irradiation technology, an anti-irradiation message that focuses on risks to consumers rather than to the environment has the potential to be very damaging to consumer demand.

Can Unfavorable Information Be Counteracted?

The results above demonstrate how negative information tends to dominate positive information. Assuming that consumers will be exposed to unfavorable information about irradiation, this suggests that it will not be sufficient for industry to promote food irradiation on its own merits—it will also need to counter the claims made by opponents. The question then, is whether the anti-irradiation message can be effectively countered—i.e., whether consumers, once exposed to anti-irradiation propaganda, can be reassured about the technology.

To address that question, we conducted experiments in which consumers could purchase irradiated or non-irradiated chicken breasts. In the experiments (Shogren et al., 1999; Fox et al. 2001), 96 consumers were provided with a U.S. Dept. of Agriculture brochure describing the food irradiation process and then asked to make a purchase choice between irradiated or non-irradiated (typical) chicken breasts. When all subjects had made their decision, they purchased and paid for the product they had chosen—and 79% purchased irradiated chicken.

The participants were then provided with a copy of the unfavorable description of irradiation used in the earlier experiment and asked whether, if allowed, they would make a different purchase decision—and the proportion choosing irradiated chicken fell to 43%.

We were then interested to find out if the claims made by Food & Water, Inc. could be countered and if confidence in the irradiated product could be restored. To counter the Food & Water, Inc. information, we used a televised report on food irradiation hosted by John Stossel of ABC News for the *20/20* news program. The report, entitled “The Power of Fear,” first broadcast on December 13, 1991, focused on protests at a food irradiation facility in Florida. Stossel interviewed the plant’s developer and representatives of Food & Water, Inc. who were leading the protest. The report concluded that food irradiation was a safe process, and Stossel indicated that, given the choice, he would actually prefer irradiated to non-irradiated meat. Furthermore, the report concluded that many of the claims made by Food & Water, Inc. were at best misleading or based on irrelevant science.

Following the video segment, we emphasized to the participants that (1) irradiated foods could never become radioactive, (2) radiolytic products, similar to those produced by irradiation, were also produced when foods were grilled or fried, (3) no studies had shown a connection between food irradiation and cancer or birth defects, (4) vitamin losses were insignificant and lower than those found in processes such as canning or freezing, (5) irradiation at approved doses did not sterilize food and spoilage warning signs were not lost, (6) there were no links between food irradiation and nuclear weapons or nuclear power, and (7) irradiation had been used to sterilize medical devices and consumer products for several decades with no problems related to the use or transportation of radioactive materials. Once again, we asked consumers to indicate what their purchase decision would be if they were allowed to repeat it—and 82% said they would choose irradiated chicken.

These results illustrate that while the anti-irradiation message is powerful, it can be effectively counteracted and confidence in the safety of the irradiation process can be restored.

Effects of Gender, Income, and Children

Studies examining the effects of demographics on decisions to purchase irradiated food have found some consistent results. Typically, they find that females are more concerned about irradiation than males and, in most but not all cases, that individuals with more formal education are more accepting of the technology. Regarding the effects of age and income, results are mixed and generally not statistically significant (see Lusk et al., 1999).

We examined results from two studies. First, we examined the set of experiments referred to above in which consumers were exposed in sequence to positive, negative, and again positive information, and we classified the consumers into different categories. Second, we examined results from a mail survey in which respondents made similar, albeit hypothetical, choices about purchasing irradiated chicken.

• **Classifying Consumers—Data from Experiments.** On the basis of the purchase decisions in the experiment, we classified consumers into three types: “proponents,” those who always preferred irradiated chicken; “opponents,” those who always preferred non-irradiated chicken; and “undecided,” those whose choice changed with new information.

Of 76 individuals who initially choose irradiated chicken based on the USDA information, 40 continued to choose it after reading the unfavorable information and were classified as “proponents.” All 20 individuals who initially chose non-irradiated chicken continued to do so after being given the unfavorable information, but after seeing the video and

discussion, seven of them switched to irradiated chicken; we classified the other 13, who continued to favor non-irradiated chicken, as “opponents.” We classified the remaining 43 subjects as “undecided.”

Next we attempted to determine which demographic factors were associated with the placement of individuals in their respective categories, using a multinomial logit model. The explanatory variables included gender, age, education, and the presence or absence of children under the age of 18 years in the household. We also asked respondents to estimate the risk of illness from consuming non-irradiated chicken, and used that risk perception as an additional explanatory variable. Presumably, the higher the perceived risk of foodborne illness, the less likely an individual would be classified as an opponent.

Table 2 summarizes the results by showing the effect, positive or negative, of the explanatory variable on the likelihood of an individual being in each classification. Double entry of a sign indicates statistically significant effects, of which, given the relatively small sample (N = 96), there are few. Two results, however, are both statistically significant and important. First, and consistent with the results of other studies, males are more likely to be classified as proponents of irradiation. Second, the presence of children under 18 is associated with opposition to irradiation. Frenzen et al. (2001) also report a negative impact associated with the presence of children (under age 5), but their result was not statistically significant at the traditionally reported levels.

Among the other results, it is worth noting the effect of more education (bearing in mind that the estimated effects are not significant). Most studies find higher education associated with more favorable attitudes to irradiation, but in this instance more highly educated consumers are more likely to be either “opponents” or “proponents” and less likely to be classified as “undecided.” This result is intuitively appealing because one does not generally associate opposition to technology with less education, and it may also explain why other studies do not always find a consistent linear impact for education. Finally, age of the respondent has no effect on classification, and, as expected, the higher the perceived risk from non-irradiated chicken the more likely one is to be a proponent of irradiation.

• **Effect of Income—Survey Data.** Concurrent with the experiments described above we conducted a mail survey (N = 229) in which respondents provided with a USDA brochure about irradiation were asked to make the same choice between irradiated and non-irradiated chicken—81% of the respondents chose irradiated chicken. We then used a statistical model (Probit) to link the probability of choosing irradiated chicken to gender, age, and other factors. Our set of explanatory variables (which did not include asking about their perception of risk from typical chicken) includes an indicator for what we term “Upscale shoppers.” These were individuals who did their food shopping in the more “upscale” of the three supermarkets in town. While we had categorical information on income, we found that the estimated coefficients on income in our regressions were never significant and that its inclusion resulted in collinearity problems. The variable for “Upscale shoppers” is a useful proxy for disposable income and, from a marketing perspective, is more informative.

The results indicate that two variables were statistically significant in explaining choice of the irradiated product. First, as we found earlier, the presence of children in the household has a significant negative effect, and second, respondents who did their shopping in the more upscale of the three supermarkets in town were significantly more likely to choose irradiated chicken. The impacts of gender, age, and education were insignificant.

Influence of Labels

Irradiated foods are required to be labeled with the radura symbol and the words ‘Treated by irradiation.’ Given the negative connotations associated with the words "radiation" and "irradiation," the labeling requirement is viewed as an obstacle to consumer acceptance. Many in the food industry believe that an alternative wording, such as the phrase “electronically pasteurized,” would be helpful.

To investigate this issue, we conducted a consumer survey that focused on the comparison between “irradiation” and “pasteurization” (Fingerhut et al., 2001). In two locations in Kansas (Manhattan and Topeka), samples were split to receive alternative versions of a mail survey: one comparing steam-pasteurization with irradiation and the other comparing hot-water-pasteurization with irradiation. Enclosed with the surveys were brochures describing food irradiation (from USDA) and the pasteurization technology (manufacturer’s information).

The survey questionnaire informed respondents about the antibacterial effectiveness of each technology: that irradiation would kill 100% of potentially pathogenic bacteria (*Escherichia coli*), steam pasteurization 99%, and hot water pasteurization 90%. Respondents were then asked whether they would prefer to purchase, at equal price, either ground beef treated by irradiation or ground beef from carcasses that had been treated by one of the pasteurization methods.

Of the 347 respondents, 62% said they would prefer to buy irradiated ground beef (100% safety) over steam-pasteurized ground beef (99% safety), and 75% said they would prefer to buy irradiated ground beef over hot-water-pasteurized ground beef (90% safety). Thus, for the majority, the choice appears to be influenced more by the microbial safety of the alternatives rather than by their labels (pasteurized vs irradiated).

Implications for Policy and Marketing

The above results have implications both for public policy and for firms interested in marketing irradiated foods. First, they illustrate that while consumers who are informed about the benefits and safety of irradiation are willing to buy irradiated foods, the anti-irradiation message is very effective in turning consumers against the technology. But the effects of unfavorable information can be neutralized, and consumer education efforts should therefore address and counteract the misperceptions fostered by opponents.

Regarding demographics, the significant (and unfortunate) consequence of these results is that young children, a group more susceptible to foodborne illness, appear less likely to benefit from the availability of irradiated foods because their mothers are less convinced about its safety. To maximize the social benefits from irradiation, education should focus on female parents. Finally, we found that for a majority of informed consumers, the choice between products labeled “irradiated” or “pasteurized” was driven by the effectiveness of the technology rather than the term used. Industry should be cautious not to overestimate the benefits of legislation that would allow use of the word “pasteurized” instead of “irradiated” on labels. Such legislation will undoubtedly provoke additional protests from consumer activists, some of whom, such as the Center for Science in the Public Interest, have recently taken a more favorable view of food irradiation. Lobbying for alternative measures, such as public education about the technology, may yield higher returns.

REFERENCES

- Bruhn, C.M. and Noell, J.W. 1987. Consumer in-store response to irradiated papayas. *Food Technol.* 41(?): 83-85.
- Bruhn, C.M. and Mason, A. 1996. Science and society: A public information program on food innovations. Final Rept. USDA FY 1994 Special Projects, Project No. 94-EFSQ-1-4141. U.S. Dept. of Agriculture, Washington, D.C.
- Fingerhut, K., Zhang, P., Fox, J.A., and Boland, M.A. 2001. Consumer preferences for pathogen-reducing technologies. *J. Food Safety* 21: 97-110.
- Fox, J.A. and Olson, D.G. 1998. Market trials of irradiated chicken. *Radiat. Phys. Chem.* 52: 63-66.
- Fox, J.A., Bruhn, C.M., and Sapp, S. 2001. Consumer acceptance of irradiated meats. In "Interdisciplinary Food Safety Research," ed. E. Murano and N. Hooker, p139-158 CRC Press, Boca Raton, Fla.
- Fox, J.A., Hayes, D.J., and Shogren, J.F. 2002. Consumer preferences for food irradiation: How favorable and unfavorable descriptions affect preferences for irradiated pork in experimental auctions. *J. Risk Uncertainty* 24: 75-95.
- Frenzen, P.D., E.E. Debess, K.E. Hechemy, H. Kassenborg, M. Kennedy, K. McCombs, A. Mcnees, The Foodnet Working Group 2001. Consumer acceptance of irradiated meat and poultry in the United States. *J. Food Protect.* 64: 2020-2026.
- Gallup. 1984. Marketability testing of irradiated fish and seafood. Canadian Gallup Poll, Ltd., Toronto.
- Lusk, J.L., Fox, J.A., and McIlvain, C.L. 1999. Consumer acceptance of irradiated meat. *Food Technol.* 53(?): 56-59.
- Pohlman, A.J., Wood, O.B., and Mason, A.C. 1994. "Influence of audiovisuals and food samples on consumer acceptance of food irradiation." *Food Technol.* 48(?): 46-49.
- Resurreccion, A.V.A., Galvez, F.C.F., Fletcher, S.M., and Misra, S.K. 1995. Consumer attitudes toward irradiated food: Results of a new study." *J. Food Protect.* 58: 193-196.
- Schutz, H.G. 1994. Consumer/soldier acceptance of irradiated food. Contract No. DAALO3-91-C-0034. U.S. Army Natick Res. Center, Natick, Mass.
- Shogren, J.F., Fox, J.A., Hayes, D.J., and Roosen, J. 1999. Observed choices for food safety in retail, survey, and auction markets. *Am. J. Agric. Econ.* 81: 1192-1199.
- Terry, D.E. and Tabor, R.L. 1988. Consumer acceptance of irradiated produce. *J. Food Distrib. Res.* 19: 73-90.
- Terry, D.E. and Tabor, R.L. 1991. Consumer perceptions of irradiated food attributes: The continuing account." *J. Food Distrib. Res.* 22: 110-111. •

Table 1: Consumer Acceptance of Irradiation

Authors	Year	Product	Acceptability
Gallup*	1984	Seafood	75% would purchase
Bruhn & Noell	1987	Papayas	92% purchased
Terry & Tabor	1988	Produce	50% would purchase
Terry & Tabor	1991	Strawberries	80% purchased
Resurreccion <i>et al.</i>	1995	Not specified	45% would purchase
Fox & Olson	1998	Chicken	80% purchased / 81% would
Frenzen <i>et al.</i>	2001	Meat	50% would purchase

* national study

Table 2: Explaining Attitudes to Irradiation

Factor	Classification		
	Opponent	Undecided	Proponent
Male	-*	-	++
Age	0	0	0
Education	+	-	+
Kids in Household	++	-	-
<i>Salmonella</i> Risk	-	-	+

* Effect on likelihood of being in a category: - = negative, + = positive, 0 = no effect
 ++ indicates statistically significant result