Factors Affecting Consumer Negative Perceptions about Beef Irradiation

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Abstract:

This study has identified several important factors affecting consumer negative perceptions about beef irradiation. The effects of these factors boil down to two main points: lack of trust in the adequacy and enforcement effectiveness of food safety regulations and consumer ignorance about the irradiation process. This implies dissemination of information about food irradiation and enhancement of consumer trust in the mechanism of food safety regulation can be effective instruments to increase consumer acceptance of beef irradiation.

I. Introduction:

Well-publicized outbreaks of food poisoning in the past decade have raised consumer concerns about the safety of their food supply. With their confidence in the safety of food supply being shaken by outbreaks of food poisoning (Adams), the American consumers are questioning the ability of the modern food system to provide safe food (Macfarlane; Smith and Riethmuller; Yeung and Morris). And food safety has become the number one concern of American consumers in recent years (Adams).

Food contamination has a tremendous health and economic consequence. According to the US Public Health Service, about 9,000 people in the US die each year from diseases caused by food contamination (Farkas; Hayes, Fox, and Shogren). Further, food contamination has caused sizable economic losses due to medical costs, loss of productivity, and loss of business (Buzby et al.; Todd). Even a single incidence of food poisoning can have such a profound effect as to destroy a brand name (Adams). Considering the tremendous damaging consequences of food contamination, food safety should be guaranteed at retail or even consumer level, and preventive programs, including development and implementation of safer food processing technologies, should be given a high priority (Farkas). Among other intervention alternatives, food irradiation, with its well-established safety and freedom from residuals, is an effective means to improve the safety of our food supply (Corry et al.; Diehl; Farkas; WHO; Wilkinson and Gould). And application of food irradiation as a preservation technology has been promoted at an international level by the World Health Organization (WHO), the Food and Agricultural Organization of the United Nations (FAO), and the International Atomic Energy Authority (IAEA).

Food irradiation has been approved by authoritative organizations to be both effective and safe

(Morehouse). It is effective in killing harmful substance in food product and safe in that irradiation does not adversely affect food quality, hence, causes no health problems to consumers (Adams; Henson; USDA, Food Safety & Inspection Service). In response to multiple outbreaks of E. Coli illnesses primarily due to consumption of hamburger meat, the US Food and Drug Administration (FDA) approved in December 1997 beef irradiation (Adams; Beef safety Information Council).

Promotion of irradiated beef has not accomplished much in the United States due primarily to consumers' resistance to food irradiation as a result of their perceived side effects of this relatively new food preservation technology. Consumer acceptance is crucial to the adoption of food irradiation and promotion of acceptance can be effective only when consumers' concerns about the side effects of irradiation, usually ungrounded, are dispelled. But consumer concerns can be dispelled only when we understand what factors affect them. Hence, for the promotion of acceptance of irradiated beef to be effective, it is necessary to obtain information on consumer negative perceptions about the use of radiation to treat beef. This study explores factors influencing consumer negative perceptions about beef irradiation, aiming to gain information useful in effectively dispelling consumers' unnecessary concerns. Insights gained in this study is useful for the design and implementation of food safety information programs related to food irradiation and may help to better understand and fully exploit the market for irradiated beef.

II. Consumer negative perceptions about beef irradiation

Food irradiation has been approved by 40 countries and endorsed by many reputable scientific groups and government agencies endeavoring to promote public health through a safer food supply. Irradiation as a means of food preservation offers many benefits, including killing disease-causing

bacteria and parasites in food, extending shelf life of food, reducing post harvest losses, and reducing food allergy (Byun et al). It is an effective way to improve food safety and reduce the incidence of foodborne diseases. Further, it is safe and environment friendly (Farkas). Almost all agents in the food supply chain can benefit somewhat from food irradiation. Consumers may benefit from lower food prices and longer home storage time, food manufacturers may benefit through reductions of production costs, food retailers may benefit from increased shelf lives in store and improvements in food merchandising efficiency (Henson). Many national and international committees, organizations and regulatory agencies, including WHO and FAO, have evaluated the credibility of irradiation as a food preservation process and recognized its benefits. In the United States, relevant authoritative government organizations unanimously have a positive perception about food irradiation. For example, the FDA approved irradiation as an effective way to kill harmful substances in food. The USDA agreed with the FDA assessments in 1999 that irradiation posed no radiation chemistry hazards, no toxicity hazards, and no adverse nutritional affects.

Despite the positive perceptions of authoritative organizations and scientific communities, consumers may have various negative perceptions about food irradiation. This is because the public and their advocates judge the benefits and risks of a food processing technology differently from authorities and experts (Macfarlane). The construction of consumer perception is highly complex and involving consideration of many factors (Henson; Slovic, Fischoff, and Lichtenstein). Among various factors affecting consumer negative perceptions is consumers' lack of knowledge about food irradiation because misunderstanding and a distorted image toward "radiation" may cause subconscious fear toward the use of radiation to treat food (Hunter). It has been reported that consumer psychological

perception problems due to a lack of public knowledge of the wholesomeness of irradiated food has resulted in opposition to food irradiation (Bruhn 1995; Resurreccion et al). Another important factor is negative information about food irradiation from consumer advocacy groups who are against the use of radiation to treat food. Some advocates were so aggressive that they threatened food processors with public denouncements, protests, and business disruption if they even considered utilizing irradiation (Adams) and their negative descriptions of food irradiation are widely available to consumers (Hayes, Fox, and Shogren). Further, the difference between consumer attitudes toward positive and negative information also plays a key role. Negative information is generally more noticeable than positive information and consumers tend to attach a greater weight to negative information and consider sources of negative information more credible than sources of positive information (Henson). Consumers' tendency to place greater weight on negative information can be so strong that claims by opponents, even if they are inaccurate and only suggest potential risks, will discourage consumer acceptance of food irradiation (Hayes, Fox, and Shogren).

Earlier studies have shown that consumers have concerns about the effects of irradiation on the intrinsic quality of food, the effects of long term consumption of irradiated food on health, health risk to employees, and environmental pollution (Bruhn,1998; Henson). In this study, We consider five negative perceptions, including nutrition reduction due to irradiation, higher level of radioactivity in irradiated food, cancer risk due to consumption of irradiated beef, environmental pollution, and harm to the health of employees. Food irradiation may result in biochemical changes that affect nutritional quality of food (Giroux and Lacroix) and consumers want information on nutritional value of irradiated food (Bruhn, 1998). Consumers' desire for nutritional information reflects their concern about

nutritional adequacy of irradiated food and we hence include the negative perception of nutrition reduction. Level of radioactivity is considered in this study because, for a lay public, the very word of "irradiation" may cause subconscious fear for harmful radioactivity in the food. As Hunter put it, "If you give someone irradiated food for the first time they will likely hesitate before they eat it because their mind will conjure up images of invisible things in the food that are going to do something to them-a subconscious fear that must be overcome to make irradiated food successful." The negative perception of cancer risk is included because consumers today have become fearful of a wide range of technologies associated with radiation and are concerned about their links with cancer (Henson).

III. Econometric Model

Consumer perceptions of beef irradiation are obtained with a set of dichotomous choice questions. Take higher radioactivity level for example, a respondent is asked whether or not he thinks beef irradiation will result in a higher level of radioactivity in beef. Assuming the probability that a respondent gives a "yes" or "no" answer is determined by a vector of observed variables, then we can form a probability model. Further, the binary nature of the perception data warrants the use of a binary choice model and probit regression analysis is applied in this study. For a specific kind of perceived negative effect of beef irradiation, the probability that a respondent will give a "yes" or a "no" answer to the relevant question can be expressed as:

$$\begin{aligned} prob(y_i = 1) &= \Phi(a + b'x_i) \\ prob(y_i = 0) &= 1 - \Phi(a + b'x_i) \end{aligned} \qquad (1)$$

where y_i is an indicator variable which is assigned a value of one if the i^{th} respondent thinks that beef

irradiation has the negative effect under consideration, zero otherwise; $\Phi(.)$ is the cumulative distribution function (cdf) of the standard normal distribution; x is a vector of explanatory variables and b is a vector of parameters to be estimated; a is the coefficient on a constant variable.

Probit models are frequently estimated using the maximum likelihood method. The log-likelihood function can be expressed as:

$$\ln L = \sum_{i=1}^{N} \{y_i \ln \Phi(a + bx_i) + (1 - y_i) \ln[1 - \Phi(a + bx_i)]\} \quad (2)$$

where N is the total number of observations of the sample. The parameter estimates of a and b in (1) can be obtained by maximizing the log-likelihood function with respect to a and b.

IV. Survey and Data

The data are from a nationwide telephone survey of US consumers conducted by the Survey Research Center of the University of Georgia in December 1999 and January 2000. The survey was primarily designed to assess consumers' perceptions of, attitudes toward, and WTP for beef irradiation. The survey instruments were developed, after a thorough review of the relevant literature, by a group of agricultural economists and survey design experts. Following a pretest of the survey instrument, telephone interviews were conducted with 740 respondents selected from a random digit-dialed sample.

In order to enhance the reliability of the information obtained from the survey, primary grocery shoppers of the households were requested to answer the survey questions. Vegetarians were excluded from the survey because the underlying good is meat. More than 99% of the respondents ate

meat at least once a week and about 93% had the experience of purchasing beef at a grocery store.

The survey results show that, in spite of authoritative approval and scientific attestation to the safety and wholesomeness of food irradiation, consumers are very concerned with the negative effects of beef irradiation. More than 40% of the respondents thought that irradiation would result in higher level of radioactivity in beef and more than 44% believed irradiation would reduce the nutrition of beef. About 25% of the respondents even believed that consumption of irradiated beef would increase the risk of suffering from cancers. As high as 45% of the respondents thought that food irradiation would adversely affect the health of the workers conducting beef irradiation and more than 45% are concerned with environmental pollution by beef irradiation.

V. Empirical Model

Five probit models are specified to explore factors affecting consumer negative perceptions about beef irradiation. Specifically, respondent's age, gender, education level, ethnic status, household income, knowledge about food irradiation, and perceptions about food safety regulations are expected to influence consumer perceptions about beef irradiation. Table 1 presents descriptions and means of the explanatory variables.

Age is included in the models to capture the effects of a possible positive relationship between age and trust in authorities on consumer perceptions about beef irradiation. Education is expected to inversely affect the probability that a consumer will have negative perceptions due to the effect of education on consumer acquisition of knowledge about the wholesomeness and safety of food irradiation. As for consumer ethnic status, white people are expected to be less likely to have negative perceptions because white people are reported to be better informed than people of other races

(United States Department of Health and Human Services). In the United States, women are often responsible for food and health issues within the household and they are typically more concerned about food safety issues than males (Steger and Witte). To capture the gender effects, we assign a dummy variable to female respondents. To account for the influence of consumers' knowledge about food irradiation on their perceptions about beef irradiation, we assign a dummy to those claiming to have sufficient knowledge about food irradiation and a dummy to those who had never heard of the process before. It is expected that consumers' knowledge about food irradiation may reduce the possibility of having negative perceptions about beef irradiation. Consumers' perceptions about food safety regulations reflect their confidence in food safety authorities and confidence in relevant authorities may affect consumers' perception about beef irradiation. Those who are unconfident in the adequacy and enforcement effectiveness of food safety regulations are expected to be more likely to have negative perception about beef irradiation.

VI. Results

The five probit models are estimated using the maximum likelihood method and the estimation results are presented in table 2. In all the five models, age is found to be inversely related to the probability of having negative perceptions about beef irradiation. The age effect may be related to consumer trust in relevant authorities. In the United States, older people are more trustful and if some authorities or reliable sources approve food irradiation to be good, they are more likely to believe it (Hunter). Older people may be more trustful in FDA's assessments that food irradiation poses no radiation chemistry hazards, no toxicity hazards, and no adverse nutritional affects and hence are less likely to have negative perceptions about beef irradiation.

More educated respondents are less likely to have the perceptions that beef irradiation may reduce nutrition, result in higher level of radioactivity, pollute environment, affect the health of workers, or increase cancer risk of consumers. More educated people have advantage in information acquisition and procession (Schultz), and thus may receive the facts of food irradiation more easily and be convinced of its merits (Hunter). Being more knowledgeable about the wholesomeness and benefits of food irradiation, more educated people are less likely to have negative perceptions about beef irradiation.

The results indicate that white people are less likely to have negative perceptions on beef irradiation regarding radioactivity level, environmental pollution, health of irradiation workers, and cancer risk. The effect of ethnic status may be due to media exposure difference between white people and nonwhites. In the United States, white people have higher newspaper and magazine readership rates (United States Department of Health and Human Services) and hence may be more knowledgeable about food irradiation. Better informed of the wholesomeness and safety of food irradiation, they are less likely to have negative perceptions about beef irradiation. But we do not have any convincing explanation why ethnic status does not have a statistically significant effect regarding nutrition loss.

Perception about food safety regulations is found to be an important determinant in all the five models. Those who consider the food safety regulations neither adequate nor effectively enforced tend to have negative perceptions about beef irradiation. In the US, food safety regulations are formulated and enforced by governmental agencies. Lack of confidence in the food safety regulations implies lack of trust in the governmental authoritative agencies. Further, food irradiation in the US requires the

approval of FDA and USDA. It could be that those lacking trust in governmental authoritative agencies do not trust FDA's assessment of beef irradiation as safe, wholesome, and beneficial, hence, they tend to have negative perceptions about beef irradiation.

As expected, knowledge about food irradiation is found to be a factor affecting consumer perception about beef irradiation. Those who have sufficient knowledge about food irradiation are less likely to believe irradiation would cause nutrition loss. On the other hand, those who had never heard of food irradiation before tend to believe consumption of irradiated beef may increase cancer risk. This implies that enhancement of consumer knowledge about food irradiation can be an effective tool to promote irradiated beef.

We expected the gender factor to have a significant impact in most of the models, but only in the environmental pollution model was it found to be an important determinant. According to the results, females are less likely to believe beef irradiation would cause environmental pollution. The gender effect is inconsistent with Nayga's finding where female main meal planners were found to be less likely to consider irradiated food to be safe than male main meal planners. Our explanation for the gender effect is that females are often responsible for food and health issues in the household and tend to pay more attention to information on food safety issues, hence, they tend to be more knowledgeable about the wholesomeness and safety of food irradiation.

VII. Concluding Remarks

Consumer resistence is commonly considered to be responsible for the failure of irradiated foods to gain a significant market share in the United States. Among various factors, negative perception about food irradiation is undoubtedly a major cause of consumer resistence. But

information lacks on what factors influencing consumer negative perceptions about food irradiation.

This study has identified several important factors affecting consumer negative perceptions about beef irradiation, including age, education, ethnic status, confidence in food safety regulations, and knowledge about food irradiation. The effects of these factors boil down to two main points, trust in food safety authorities and information about food irradiation. For example, the effects of education and ethnic status may reflect the impacts of information acquisition ability and extent of media exposure while the effects of age and confidence in food safety regulations indicate the impacts of trust in relevant authorities. This implies that negative perceptions about beef irradiation can be effectively dispelled by enhancing consumer trust in food safety authorities and by disseminating information about food irradiation to consumers. In turn, information dissemination and trust enhancement can be effective instruments to promote beef irradiation.

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Table 1. Description and means of the explanatory variables.

Variable	Description	Mean
Age	Actual age of the respondent.	49.9527
Female	= 1 if the respondent is a female, 0 otherwise.	0.6932
White	= 1 if the respondent is a white people, 0 otherwise.	0.8027
Education	1 = less than high school graduation, 2 = high school graduation, 3 = some college education, 4 = college degree, 5 = post graduation or professional.	3.1108
Ineffective	= 1 if the respondent thinks the food safety regulations are adequate, but not effectively enforced, 0 otherwise.	0.4635
Notsafe	= 1 if the respondent thinks the food safety regulations are neither adequate nor effectively enforced, 0 otherwise.	0.2392
Informed	= 1 if the respondent is sufficiently informed about the irradiation process, 0 otherwise.	0.0527
Neverheard	= 1 if the respondent has never heard of the irradiation before, 0 otherwise.	0.3568

Table 2. Maximum likelihood estimates of probit models of five consumer negative perceptions about beef irradiation.

Variable	Increase Cancer risk	Higher level radioactivity	Nutrition loss	Harmful to employee	Environmental pollution
Constant	-0.0771 (0.2504)	0.5549** (0.2345)	0.7039*** (0.2353)	0.7655*** (0.2330)	0.9444*** (0.2355)
Age	–0.0056** (0.0027)	-0.0088*** (0.0025)	-0.0113*** (0.0025)	-0.0061** (0.0024)	-0.0089*** (0.0025)
Female	0.1009 (0.1146)	-0.0928 (0.1047)	-0.1519 (0.1044)	-0.0949 (0.1037)	-0.2065** (0.1038)
White	-0.3079** (0.1263)	-0.2089* (0.1207)	-0.0335 (0.1205)	-0.3584*** (0.1204)	-0.2481** (0.1204)
Education	-0.1013** (0.0412)	-0.0878** (0.0368)	-0.0647* (0.0368)	-0.0936*** (0.0357)	-0.1068*** (0.0367)
Ineffective	0.0006 (1233)	0.0437 (0.1128)	0.0198 (0.1123)	0.0146 (0.1112)	0.0735 (0.1116)
Notsafe	0.3490** (0.1387)	0.3117** (0.1299)	0.3137** (0.1302)	0.2639** (0.1291)	0.2456* (0.1294)
Informed	-0.1478 (0.2542)	-0.0671 (0.2226)	-0.6716*** (0.2357)	-0.2987 (0.2224)	-0.2078 (0.2173)
Neverheard	0.1883* (0.1094)	0.0917 (0.1025)	-0.0483 (0.1023)	-0.0074 (0.1022)	-0.0987 (0.1026)
McFadden R^2	0.0409	0.0341	0.0414	0.0314	0.0354
N	740	740	740	740	740

Note:
Standard errors are in parentheses.
* denotes significant at 0.1 level, ** denotes significant at 0.05 level, *** denotes significant at 0.01 level.