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Increasing Positive Perceptions of Food Irradiation: Appealing to One's Affective Domain

Abstract
A study tested the effectiveness of experiential learning techniques in food irradiation technology to positively influence understanding in both the affective and cognitive domain. Research shows that food irradiation is a safe food technology effective at reducing foodborne illness, but the adoption rate of the technology remains slow. The short course employed experiential components, such as tours of food irradiation facilities, group activities, and taste-tests of irradiated produce. Data were collected assessing participants' knowledge and perceptions about food irradiation, using Likert-type scales. The short course produced significant gains in participants' knowledge and positively influenced participants' perceptions of food irradiation issues.

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Introduction

In 1905, a British patent was issued that proposed using irradiation to kill bacteria in food

(Andress, 2001; Diehl, 2002). From that point, there has been extensive research conducted that shows food irradiation to be a safe food technology, effective in reducing pathogenic microorganisms, prolonging shelf-life, and controlling pests. Despite this history of scientific research, food irradiation technology has yet to be widely adopted. It is common for decisions about new foods and risk to invoke emotional and intuitive behavior based upon selective perception (Hoban, 1996; "Improving risk communication," 1989). Some consumers are hesitant to adopt unfamiliar technologies, especially when the technology pertains to something as critical and personal as the production of their own food ("Improving risk communication," 1989).

While food irradiation is a technology with over a 100-year history, its adoption rate by food industry professionals and consumers has been very slow. A possible explanation for this slow rate of diffusion could be attributed to the outrage factor. Outrage is defined as the acceptability of a risk that is influenced by such characteristics of the risk such as voluntariness, control, familiarity, and dread (Sandman, 1987). Sandman (1987) explained risk as the combination of both hazard and outrage. According to Groth (1991), food irradiation is a high outrage but low hazard risk, while microbes in food are a low outrage yet high hazard risk. Groth (1991) suggested that in order for scientists to develop effective educational programs, they should understand how the public interprets risk.

Sandman (1987) pointed out that while non-technical citizens put too much emphasis on the outrage side of a risk, scientists and experts tended to downplay outrage completely. Bruhn (1994) described previous studies demonstrating that most consumers would buy irradiated foods once educated. Her point was that the expression of concern about a new technology does not need to halt the adoption, but rather accentuated the need for education (Bruhn, 1994). In order to maintain trust and credibility, educators must acknowledge the public's outrage, values, and feelings (all of which fall into one's affective domain) about a new technology (Hutcheson, 1999).

Zimmerman, Kendall, Stone, and Hoban (1994) recommended that prior to designing an educational program, an assessment be conducted to determine whether consumers' attitudes about new food technologies originated cognitively or affectively. Perception is based on both one's past experience with, and knowledge of, a topic. In the absence of experience and knowledge, a person cannot accurately perceive the topic (May, 1969). When knowledge about the topic or technology is low, people form perceptions based on global attitudes they already have toward similar topics or technologies (Sanbonmatsu & Fazio, 1990; Fazio, Powell, & Williams, 1989). When confronted with such affective-based attitudes, affective messages have been found more effective at modifying perceptions than cognitive-based messages, especially when subject knowledge is low, such as with food irradiation (Edwards, 1990). Therefore affective domain experiences should be provided people that establish new reference points in their perspective concerning new technologies.

An educational intervention, the short courseImproving Safety of Complex Food Items Using Electron Beam Technology, was conducted to discuss the safety and latest innovations in electron beam technology to enhance food safety and phytosanitation of complex food items such as fruits and vegetables. This purpose of the study reported here was to determine if an experiential education intervention positively influences not only cognitive understanding of food irradiation, but affective (perceptual) understanding as well. Specifically, we investigated if Extension programs could simultaneously educate in the cognitive and the more often overlooked affective domain.

Methods

Twenty-three professionals participated in the short course, and paired pretest/post-test data were collected from 19 (86%) males and three (14%) female participants (*N* = 22). Eighteen participants were food safety regulators, three were Extension educators, one participant was a food processor, and another participant worked for a port authority. Seven participants (32%) held Doctorate degrees, three (14%) held Master's degrees, six (27%) held Bachelor's degrees, and six (27%) held high school or equivalent degrees. Eleven respondents (50%) were 50-59 years old at the time of the short course, six participants (27%) were 40-49 years old, and four participants (18%) were 30-39 years old. Twelve participants (55%) were Caucasian, six participants (27%) were Hispanic American, and four participants (18%) indicated they were multi-racial (Asian American, Polynesian, and Indian). Sixteen participants (73%*)* had 11 or more years of professional experience in the food industry (Department of Health, food inspectors, etc.) or Cooperative Extension Service.

The short course Improving Safety of Complex Food Items Using Electron Beam Technology, was conducted over a 3-day period at the Institute of Food Science & Engineering on the campus of Texas A&M University. Short course topics included:

- Consumer concerns about and acceptance of irradiation
- Status of food irradiation around the world
- Comparison of quality, health, and nutritional properties of fresh fruits and vegetables pre- and post-irradiation

- Analysis of the economics of food irradiation from the perspective of both the consumer and the producer
- Use of irradiation for microbial safety in fresh-cut produce
- Phytosanitary applications of electron beam (e-beam) irradiation in fruits and vegetables
- Use of irradiation to extend shelf life
- Irradiation dosimetry for irregularly shaped products, such as whole fruits and vegetables

The short course consisted of presentations by experts in food irradiation technology, tours of food irradiation facilities, group discussions, and an irradiated produce and meat tasting. Participants were educated of the difference between radio-isotope technology and electron beam technology. Participants toured the Texas A&M University nuclear test facility housing radio isotopes used for research and medical applications, and were tested for radioactive exposure before and after the tour. The key component of the short course, a tour of the Texas A&M Electron Beam Food Research facility, did not require testing for radioactive exposure and incorporated several experiential education elements such as: irradiation facility and dosimetry lab tours; interaction with scientists and engineers; and irradiated produce taste tests.

To build participants' global experiences, reduce outrage, influence the affective domain, and provide a new reference point in their perspective of electron beam technology for future instances, the taste tests included participants viewing 3-5 day old irradiated and un-irradiated fruits and vegetables and consumption of the electron beam irradiated produce. Participants' affective domain was influenced by visually seeing the difference between the spoiled and rotting un-irradiated produce and the unspoiled electron beam irradiated produce, and demonstrated confidence in the safety of irradiated products by consumption of the irradiated produce. Participant feedback throughout the short course was solicited and incorporated. At the end of each day, specific educational interests and needs of participants were discussed in a round table format. This open dialogue allowed participants to share individual experiences and perceptions with the group, further influencing the affective domain.

Short course data were collected usingLikert-type scaled paired pre- and post-tests that assessed participants' knowledge and perceptions about food irradiation. Participants completed both pre- and post-tests as part of the short course via the Internet site <http://www.ag-communicators.org/surveys/FIPCES.asp>. Online test delivery was selected due to its ability to gather fast, accurate responses with minimal expense (Ladner, Wingenbach, & Raven, 2002). Assistance was available for navigating the Web page and completing the assessment for participants who were not comfortable with online delivery methods.

Participants indicated their level of agreement to 18 statements that measured perceptions about food irradiation and food safety issues. Responses ranged from strongly disagree (1) to strongly agree (4) on a four-point Likert-type scale. Scale reliability of the instrument was determined using Cronbach's coefficient alpha (Cronbach, 1951). Mehrens and Lehmann (1973) stated a coefficient of 0.65 denoted a satisfactory level of internal consistency and reliability. Nunally (1976) further indicated a coefficient is adequate if it is from 0.60 to 0.79 and rated excellent if it is greater than 0.80. Reliability analysis of the instrument yielded a Cronbach's coefficient alpha of 0.85 in the pretest and 0.91 in the post-test, indicating the instrument reliably measured participants' perceptions of food irradiation and food safety issues.

Knowledge of food irradiation was assessed by respondents' answers to five multiple-choice questions directly derived from the short course instructional materials. Sample questions included: "Approved doses of food irradiation can:" (answer) "destroy bacteria;" and, "Compared to cooked or frozen food, food that is irradiated at approved doses has:" (answer) "similar nutritional value."

Additional understanding of the impact from the Improving Safety of Complex Food Items Using Electron Beam Technology short course was garnered from analyses of paired samples *t*-tests. Tests were conducted on the summed scaled response sets for food safety and food irradiation knowledge and perceptions. Mean knowledge was derived from a possible perfect score of five correct responses. Participants' overall perceptions of food safety and food irradiation were determined from the summated perceptions responses on a four-point Likert-type scale.

Findings

Participants indicated their levels of agreement for 18 statements to measure perceptions about food safety and food irradiation issues (Table 1). In the post-test, respondents agreed more strongly with the following statements than they had in the pretest:

- I would buy irradiated food if it were available.
- Irradiation will improve the safety of food available to consumers.
- I would serve irradiated foods to my family.

- I feel scientifically confident about food irradiation.

Respondents disagreed with the following statements in the pretest and disagreed more strongly with them in the post-test:

- Irradiated food causes cancer.
- Irradiation will make food radioactive.

Table 1.
Participants' Perceptions of Food Safety and Food Irradiation Pre- to Post-Short Course (N = 22)

		Pre-Test		Post-Test				
Statement	**df**	***M***[a]	***SD***	***M***[a]	***SD***	***d***[b]	***t***	**Sig.**
I am interested in learning more about food safety issues.	21	3.82	0.39	3.86	0.35	.11	-.57	.58
Foodborne illness caused from bacteria on meats is a serious problem.	21	3.32	0.72	3.77	0.43	1.05	-3.18*	.00
Irradiation will improve the safety of food available to consumers.	21	3.50	0.51	3.68	0.48	.38	-1.70	.10
Food that has been irradiated is safe to eat.	21	3.32	0.65	3.68	0.48	.75	-2.59*	.02
Foodborne illness caused from bacteria on fruits and vegetables is a serious problem.	21	3.32	0.57	3.64	0.49	.65	-2.31*	.03
Food that has been irradiated can become re-contaminated.	20	3.29	0.64	3.71	0.56	.75	-3.29*	.00
I am interested in learning more about food irradiation.	21	3.68	0.48	3.64	0.49	.08	.44	.67
Food irradiation has been endorsed by the American Medical Assn. and American Dietetic Assn.	20	2.86	0.57	3.52	0.60	1.10	-3.84*	.00
I would buy irradiated food if it were available.	20	3.29	0.56	3.38	0.74	.12	-.57	.58
I would serve irradiated foods to my family.	21	3.23	0.75	3.36	0.73	.18	-1.00	.33
I feel comfortable informing customers about food irradiation.	20	2.90	0.77	3.38	0.59	.81	-2.91*	.01
I feel scientifically confident about food irradiation.	19	3.00	0.86	3.30	0.47	.64	-1.83	.08
Not enough research has been done to prove that food irradiation is safe.	21	2.82[a]	0.85	2.91[a]	0.75	.12	-.40	.69
Irradiation can be used to make spoiled foods marketable.	21	3.36[a]	0.79	3.41 [a]	0.85	.06	-.21	.83
Food irradiation reduces the nutritional content of food more than other processing techniques.	21	3.18[a]	0.73	3.41[a]	0.59	.39	-1.16	.26
Irradiation facilities give off radiation to the surrounding community.	19	3.55[a]	0.60	3.60[a]	0.60	.08	-.29	.77
Irradiated food causes cancer.	19	3.35[a]	0.67	3.75[a]	0.44	.91	-2.99*	.01
Irradiation will make food radioactive.	21	3.55[a]	0.60	3.77[a]	0.43	.51	-2.49*	.02

Students will benefit knowing about food irradiation as it relates to health and wellness.	21	3.68	0.48	3.64	0.49	.08	.44	.67
I would teach about food irradiation if I had more knowledge on the topic.	21	3.32	0.65	3.36	0.49	.08	-.33	.75
Note. [z]Likert-type scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Agree; 4 = Strongly Agree. [a] Indicates items that were reverse coded, therefore higher scores indicate statement disagreement. *$P < 0.05$. [b] Cohen's measure of effect size (.20 = small, .50 = medium, .80 = large).								

Respondents' knowledge of food irradiation was assessed by their responses to five multiple-choice questions. The frequency of correct responses for each individual question ranged from 7 to 21 in the pretest and 15 to 22 in the post-test. Some respondents chose not to answer all questions in each test. Most respondents (N = 14) answered the following two questions incorrectly on the pretest but answered them correctly (N = 18 and 15 respectively) on the post-test:

- Approved doses of food irradiation can: (answer) destroy bacteria.
- Which is NOT a benefit of food irradiation at approved doses? (answer) Makes fresh meat and poultry shelf-stable (Table 2).

Table 2.
Participants' Correct and Incorrect Answers for Short Course Pre- and Post-Knowledge Questions (N = 22)

Knowledge Question	**Pre-Test[z]**		**Post-Test[z]**	
	Correct	**Incorrect**	**Correct**	**Incorrect**
Food irradiation [a]can be an additional food safety processing step.	21	1	22	
Irradiation [a]damages the DNA of microorganisms.	14	8	17	4
Approved doses of food irradiation can [a]destroy bacteria.	7	14	18	4
Which is NOT a benefit of food irradiation at approved doses? [a]Makes fresh meat and poultry shelf-stable.	8	14	15	7
Compared to cooked or frozen food, food that is irradiated at approved doses has [a]similar nutritional value.	21	1	21	1
Note. [z] Total responses may not equal 22 due to missing answers. [a] Correct answer to the question.				

Paired samples *t*-tests of the five multiple choice questions for food irradiation knowledge revealed the short course produced statistically significant (ï¡ = 0.05) knowledge gains pre-short course ($M = 3.23$) to post-short course ($M = 4.23$). The number of incorrectly answered knowledge questions ($N = 16$) in the post-test indicated additional food irradiation training would be beneficial for the respondents. Paired samples *t*-tests also indicated statistically significant (ï¡ = 0.05) improvement in participants' perceptions of food safety and food irradiation issues pre-short ($M = 58.14$) to post-short course ($M = 63.09$) (Table 3).

Table 3.
Paired Samples t-Test for Participants' Food Safety and Food Irradiation Knowledge and Perception (N = 22)

Summated Scales		**Pre-Test**		**Post-Test**				

	df	*M*	*SD*	*M*	*SD*	*d* [c]	*t*	Sig.
Food Irradiation Knowledge	21	3.23[a]	1.07	4.23 [a]	0.75	.98	-4.58*	.00
Food Safety and Food Irradiation Perceptions	21	58.14[b]	7.66	63.09 [b]	6.48	.89	-4.17*	.00

*$P < 0.05$.

[a]Average number of five multiple choice answers correct.

[b]Summated scale where strongly disagree = 22 - 33; disagree = 33.1 - 55; agree = 55.1 - 77; and strongly agree = 77.1 - 88

[c] Cohen's measure of effect size (.20 = small, .50 = medium, .80 = large).

Conclusion

The study reported here indicated effective educational programs have the potential to positively influence both a person's cognitive and affective perceptions of unfamiliar technologies. The educational intervention produced significant knowledge gains in food safety and food irradiation knowledge and significantly increasing participants' positive attitudes and perceptions regarding Electron Beam technology for food irradiation. Concerns voiced by food irradiation opponents were addressed directly and scientifically. These common consumer concerns tend to be high outrage, low hazard in nature, and dealing with these concerns without being defensive is the most effective method for educating the public (Hutcheson, 1999).

Participants involved in the Improving Safety of Complex Food Items Using Electron Beam Technology short course indicated a significant increase in their overall knowledge of Electron Beam irradiation technology after completion of the short course. The short course increased participants' perception of Electron Beam irradiated produces' safety for human consumption and decreased perceptions of Electron Beam irradiation creating radioactive produce and causing cancer in consumers. Participants' also indicated increased confidence to inform produce customers about food irradiation. These results indicate the short course successfully reduced participants' outrage toward Electron Beam food irradiation technology by providing a new reference point in their global perception of this technology through positively influencing not only the cognitive domain, but the affective domain as well.

Extension professionals have a mission to provide research-based information in their educational programs. However, as studies such as the one described here indicate, Extension educators may find that merely presenting scientific data in order to appeal to cognitive understanding will not be effective. Extension programs must consider affective understanding in order to effectively reach audiences particularly for high outrage, low hazard risks such as food irradiation or pesticide use.

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