

FAMILY AND CONSUMER SCIENCES TEACHERS' CHANGES IN ATTITUDES AND KNOWLEDGE ABOUT FOOD IRRADIATION

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Immediate and longer-term changes in attitudes and knowledge of high school family and consumer sciences teachers regarding food irradiation were assessed using a repeated measures design to assess the effects of a professional development workshop on food safety and food irradiation. Data were analyzed within six constructs relative to food irradiation, including the teachers' attitudes towards its safety, their desire to learn more, their perceived levels of understanding and competence in teaching about it, their perceived risk of foodborne illness, and their knowledge of the subject. Results revealed significant positive changes in attitudes and knowledge, both immediate and longer-term, suggesting the workshop contributed to increased knowledge and more positive attitudes about food irradiation.

Food irradiation is a food processing technology used for improving the safety and quality of food, and has been scientifically researched for over 50 years (Diehl, 1995; Smith & Pillai, 2004). It has been shown to destroy harmful microorganisms in foods that cause foodborne illnesses in humans, and can extend the shelf life of produce (Smith & Pillai). Currently, irradiated food is commercially available at more than 4,000 foodservice outlets and retail chains in the U.S. (Minnesota Beef Council, 2004).

Consumers, however, have been slow to adopt food irradiation, with only 50% reporting they would buy and 25% indicating they would pay a premium for irradiated food if it were available, even though most are highly concerned about food safety and rank foodborne illness as a top concern (Frenzen, DeBess, Hechemy, Kassenborg, Kennedy, McCombs, et al., 2001; Troxel, 2000). Estimates support that foodborne illness in the U.S. still results in approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths annually (Mead et al., 1999).

Education, Knowledge, and Attitudes on Food Irradiation

Education about food safety and the benefits of food irradiation technology can be effective in influencing a person's knowledge and attitudes about food irradiation (Bruhn, 1998; Eustice, 2004; Pohlman, Wood, & Mason, 1994). Studies have revealed that persons familiar with or knowledgeable about food irradiation were more likely to purchase irradiated products

compared to those who were unfamiliar with the process (Bruhn; Fox, 2002; Troxel, 2000). However, recent studies suggest that consumers may be more receptive to negative and/or misinformation about food irradiation rather than positive information (Fox; Fox, Hayes, & Shogren, 2002). These facts underscore the importance of education and the need for teachers to provide effective education in this area.

Consumers' attitudes toward food irradiation are largely based on the knowledge and information they have received about the technology. Consumers typically harbor misconceptions associated with food irradiation, including: irradiation will cause food to become radioactive and/or toxic, irradiation will be used to make spoiled food marketable, irradiation will replace good manufacturing practices, and irradiation will alter the nutritional content of foods (Bruhn, 1998; Resurreccion & Galvez, 1999). In addition, previous research studies have found that consumers' acceptance of irradiated foods are impacted by their different demographic variables, such as ethnicity, gender, level of education, and household status (Fox, 2000; Fox et al., 2002; Nayga, Poghosyan, & Nichols, 2004; Troxel, 2000) although results about specific impacts have been mixed.

Educators differ from consumers in regards to food irradiation knowledge and attitudes because of their occupational association with the generation of knowledge. Family and consumer sciences teachers have the ability to disseminate information on food irradiation to a range of audiences, including their students and the public. Research conducted more than a decade ago suggested that nutrition educators, including family and consumer sciences high school teachers and county Extension agents, held neutral to positive attitudes about food irradiation but had limited knowledge about it (Johnson, 1990). Recent research indicates that family and consumer sciences county Extension educators hold neutral beliefs and limited knowledge regarding food irradiation (Thompson & Knight, 2006a; Thompson & Knight, in press, Thompson, Schielack, & Vestal, 2004). A more recent study conducted by the authors revealed that even though family and consumer sciences high school teachers hold neutral to positive attitudes about the safety of irradiated foods, their perceptions of the risk of foodborne illness, and their attitude towards learning about food irradiation, they possess neutral to negative perceptions of their understanding of food irradiation and their competence to teach about the topic (Thompson, Phelan, Wingenbach, & Vestal, 2006).

Educating the Educator

A review of research on educators' knowledge and belief systems reveals that familiarity with and knowledge about a subject matter influences teaching behaviors related to that subject, with knowledge and beliefs collectively comprising a teacher's knowledge base (Munby, Russell, & Martin, 2002). Education in the form of professional development can play an important role in shaping the knowledge and beliefs of teachers. At the basic level, education is concerned with transforming beliefs and generating new knowledge and understanding (Southerland, Sinatra, & Matthews, 2001). Professional development can improve educators' perceived competency in providing education about certain subjects, which can affect an educator's desire or ability to teach within that subject, according to Berliner and Calfee (as cited in Munby, Russell, and Martin). For purposes of this manuscript, beliefs will be referred to as attitudes, since they are considered synonymous (Pajares, 1992).

Purpose and Research Questions

The purpose of our study was to determine the effects of an educational intervention/professional development workshop with regard to changes in family and consumer sciences teachers' attitudes and knowledge about food irradiation. Specifically, our objectives were to (1) describe family and consumer sciences teachers' baseline attitudes, understanding, and knowledge about food irradiation, and (2) determine immediate and longer-term changes in food irradiation attitudes and knowledge following a professional development workshop on food safety and food irradiation.

Methods

Data Collection

To determine changes in the food irradiation attitudes and knowledge of family and consumer sciences high school teachers, the authors administered a pre-test 2.5 months before the professional development workshop, a post-test immediately after, and a delayed post-test approximately 10 months after a workshop on food irradiation, using a previously validated instrument. This close-ended instrument, known as the Food Irradiation Teacher Assessment (*FITA*) (Thompson et al., 2006), was administered online via a secure Web link (Ladner, Wingenbach, & Raven, 2002) after obtaining approval to conduct the study from the Texas A&M University Institutional Review Board.

Participants

The pre-test was completed by 121 randomly selected high school family and consumer sciences teachers in Texas who taught Food Science and Technology, Nutrition and Food Science, and/or Food Production, Management, and Services (Thompson et al., 2006). Of the 121 respondents who participated in the benchmark survey, 29 teachers were randomly selected to participate in a food irradiation professional development workshop. Most of the 29 teachers were female (99%), Caucasian (90%), and had taught at least 11 years (67%). All had a bachelor's degree, 35% had earned a master's, and most had never participated in a food irradiation training (85.7%). Twenty-eight survey responses were collected immediately after the workshop and during the delayed post-test, for a response rate of 96.6% from the 29 participants who attended the professional development workshop.

Instrument

Participants indicated their agreement to 19 attitudinal items, identified their perceived understanding of food irradiation via two rating questions, and responded to six multiple choice questions regarding food irradiation concepts. The 19 attitudinal items were rated on a five-point Likert-type scale ranging from "strongly disagree" to "strongly agree" addressing attitudes about the safety of food irradiation (*Safety*), learning about food irradiation (*Learning*), competency in teaching about food irradiation (*Competence*), and the risks of foodborne illnesses in the United States (*Foodborne Illness Risk*). Respondents rated their understanding of food irradiation (*Understanding*) using a four-point scale from "poor" (1) to "excellent" (4). To measure knowledge of food irradiation (*Knowledge*), participants responded to six multiple-choice items. Sample questions included: "Compared to cooked or frozen food, food that is irradiated at approved doses has (answer: similar nutritional value)", and "Consumption of irradiated food is associated with (answer: decreased risk of foodborne illness)". Demographic data (gender, age, ethnicity, years of teaching experience, and educational level) were collected at pre-test.

Intervention

The two-day professional development workshop, held on the campus of Texas A&M University, focused on food safety and food irradiation. The goal of the workshop was to expose high school family and consumer sciences teachers to the most current research and science in the area of food microbiology and the emerging food safety technology of food irradiation. The workshop incorporated various learning activities related to food safety and food irradiation, including: participating in presentations by food microbiology and food irradiation scientists and experts from multiple universities, touring a local food processing facility, touring an electron beam food irradiation research facility, as well as focusing on the development of classroom applications regarding current science related to food microbiology and food irradiation. Upon conclusion of the workshop, the researchers administered the *FITA* using a computer lab and directing the participants to an online link.

Data Analysis

A previous study established six scales, or constructs, of the *FITA*: *Safety*, *Competence*, *Learning*, *Foodborne Illness Risk*, *Understanding*, and a *Knowledge* component (Thompson et al., 2006). To obtain a score for each scale, Likert-type items were recoded so that higher scores reflected beliefs that were more favorable to food irradiation (Crocker & Algina, 1986).

Descriptive and inferential statistics were determined using the Statistical Package for Social Sciences (SPSS 12.0, Chicago, IL). Mean and standard deviation were calculated for each item and scale. Statistically significant differences between respondents' pre-, post-, and delayed post-test scale scores were analyzed via repeated measures analysis of variance using the Bonferroni-corrected post hoc procedure. Because statistically significant outcomes do not provide information regarding the size or strength of the outcome, or "quantitative estimate of practical significance" (Rennie, 1998, p. 238), we estimated the strength of the association via partial eta (η). Guidelines for interpreting effect size estimates for measures of association suggest that coefficients of .10, .30, and .50 are small (negligible practical or educational importance), medium (moderate practical or educational importance), and large (crucial practical or educational importance), respectively (Hojat & Xu, 2004).

Results

Food Irradiation Attitudes

Overall, participants held relatively neutral attitudes regarding food irradiation before the workshop. Table 1 shows the mean and standard deviation for each item, organized by scale. Participants were neutral to positive regarding the safety of food irradiation (*Safety*) and the risk of foodborne illness (*Foodborne Illness Risk*). They held positive attitudes regarding learning about food irradiation (*Learning*); however, they had negative self-efficacy attitudes regarding their ability to teach about the topic (*Competence*).

Table 1
Descriptive Statistics for Each Attitudinal Item of the Food Irradiation Teacher Assessment (FITA) at Pre-test, Organized by Scale (n = 28)

	<i>M</i>	<i>SD</i>
Safety^a		
Food that has been irradiated is safe to eat.	3.54	.79
I would serve irradiated food to my family.	3.07	.98
I would buy irradiated food if it was available.	3.11	.99
Not enough research has been done to prove that food irradiation is safe.(-)	2.79	.96
Consuming irradiated food could be harmful to me in the future.(-)	3.44	.83
Food irradiation destroys the nutritional content of food more than other processing techniques.(-)	3.50	.84
Irradiated food causes cancer.(-)	3.33	.77
Irradiation facilities give off radiation to the surrounding community.(-)	3.57	.63
Irradiation will make food radioactive.(-)	3.96	.74
Learning^a		
I am interested in learning more about food safety technologies.	4.79	.42
Students will benefit from knowing about food irradiation.	4.57	.50
I am interested in learning more about food irradiation.	4.68	.48
Competence^a		
I feel competent teaching about food irradiation.	2.00	.94
I feel confident teaching about food irradiation.	2.07	1.02
Foodborne Illness Risk^a		
I believe foodborne illness caused from bacteria in meats is a problem in the U.S.	3.89	.88
I believe foodborne illness caused from bacteria in fruits and vegetables is a problem in the U.S.	3.39	.88
Understanding^b		
How would you rate your knowledge of food irradiation?	1.39	.63
How would you rate your understanding of the technology behind food irradiation?	1.29	.46

Note: ^aItems on a five-point scale. (-) Items reverse coded so that higher scores reflect more favorable attitudes towards food irradiation. ^bItems on a four-point scale.

Repeated measures ANOVA scale scores at each time point revealed statistically significant results. Participants' attitudes towards the *Safety* of food irradiation, their *Competence* to teach about it, and their *Understanding* were statistically significantly higher on post-test and delayed post-test compared to pre-test results (Table 2). Effect size analysis indicated large estimated effects for *Safety* ($\eta = .82$), *Competence* ($\eta = .88$), *Understanding* ($\eta = .91$), supporting the educational importance of these outcomes (Table 2).

Table 2

Repeated Measures ANOVA of High School Family and Consumer Sciences Teachers' Attitudes toward Food Irradiation, as assessed on the FITA (n = 28)

Scales*	Pre	Post	Delayed	df	F	p	η
Understanding	2.68 (.98) _a	6.21 (1.10) _b	5.89 (1.23) _b	2, 54	133.60	<.001	.91
Competence	4.07 (1.70) _a	8.32 (0.77) _b	8.07 (1.49) _b	2, 54	96.08	<.001	.88
Safety	30.31 (5.49) _a	40.63 (4.75) _b	39.56 (4.48) _b	1.47, 39.76	58.25	<.001	.82
Learning	14.04 (1.10) _a	14.56 (0.79) _{ab}	13.89 (1.10) _{ac}	2, 54	5.53	.007	.41
Foodborne Illness Risk	7.29 (1.54) _a	8.96 (1.37) _b	7.71 (1.84) _a	2, 54	14.13	<.001	.58
Knowledge	4.39 (1.13) _a	5.86 (.36) _b	5.32 (.77) _c	1.53, 41.16	27.73	<.001	.71

Note. * Individual items were summated to determine respondents' overall attitudes in four factors. Maximum scale points for *Understanding*, *Competence*, *Safety*, *Learning*, *Foodborne Illness Risk*, and *Knowledge* was 8, 10, 45, 15, 10, and 6, respectively. ^{a/b/c} Scores not sharing a letter are statistically significantly different between time points for each scale.

Participants' attitudes towards *Learning* were similar between pre-test and both post-test and delayed post-test. This finding was not surprising given the pre-test mean of 14.04 ($SD=1.10$) out of a possible 15 points, indicating that teachers felt learning about food irradiation was important before and after the workshop. *Learning* scores decreased between post-test and delayed post-test; although the decrease was significant, effect size analysis revealed a medium effect size (Table 2), meaning this was of moderate educational importance.

Scores on the *Foodborne Illness Risk* scale increased from pre- to post-test and then returned to baseline at delayed post-test. Interestingly, this was the only scale in which attitudes statistically significantly increased immediately after the workshop and then returned to pre-test levels on the delayed post-test. Effect size analysis of these scores indicated a large effect. Figure 1 provides a graphical representation of the scale score trends for all scale scores across time points, plotted as a percent of the total possible points.

Food Irradiation Knowledge

During each administration, the food irradiation knowledge of participants was assessed via the *FITA*. Analysis revealed that participants made statistically significant gains in their knowledge of food irradiation, as assessed via the 6 multiple-choice items on the *FITA*. Specifically, post-test and delayed post-test scores were statistically significantly higher when compared to pre-test scores (Table 2), even though a decrease was noted between post-test and delayed post-test. Effect size analysis indicated that the increases in knowledge were large.

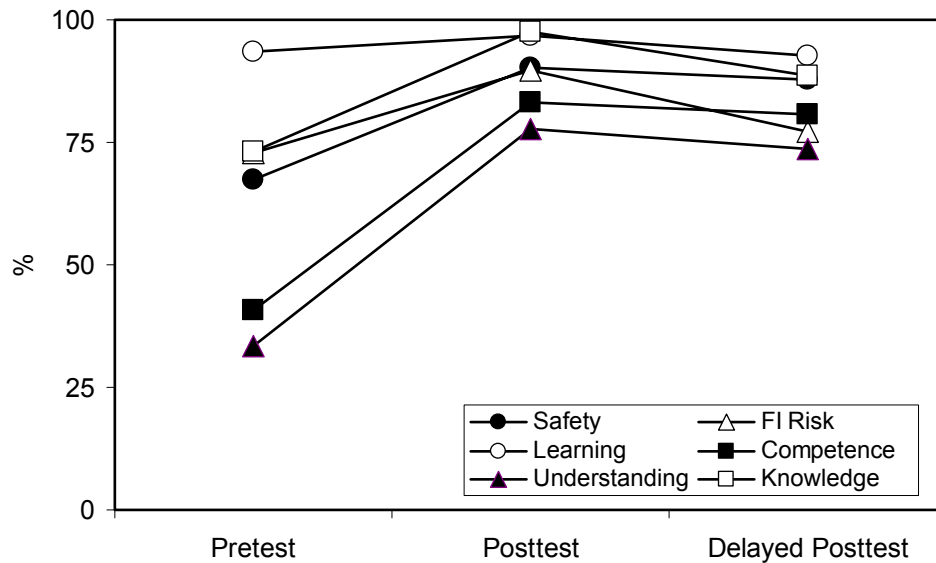


Figure 1.

Changes in levels of *Understanding*, *Competence*, *Safety*, *Learning*, and *Foodborne Illness Risks* of high school family and consumer sciences teachers as assessed on the *FITA* (n=28). Pre-test administered 2.5 months before participants attended a food irradiation professional development workshop, post-test administered immediately after the workshop, and delayed post-test administered 10 months after the workshop. Scores on each scale of the *FITA* are graphed as a percentage of the total maximum points.

Discussion and Conclusions

The purpose of this study was to determine the effects of an educational intervention/professional development workshop with regard to changes in Texas family and consumer sciences teachers' attitudes and knowledge about food irradiation. To accomplish our purpose, our specific objectives were to (1) describe family and consumer sciences teachers' baseline attitudes and knowledge about food irradiation, and (2) determine differences between teachers' pre-, post-, and delayed post-test attitudes and knowledge of food irradiation.

Family and consumer sciences educators provide knowledge and guidance about daily living, including a focus on nutrition and food health, for purposes of improving living conditions for individuals (Baugher et al., 2005). Family and consumer sciences teachers possess the ability to disseminate information on the topic of food irradiation to a range of audiences; therefore, it is important to provide professional development opportunities to enhance their knowledge, attitudes, and technical competencies regarding food irradiation. It is important to note that consumer acceptance of complex public health-related technologies, such as food irradiation, is dependent on sound, science-based public education (International Council on Food Irradiation, 2003).

This study utilized a repeated measures approach to data collection, assessing participants 2.5 months before the professional development workshop (pre-test), immediately after (post-test), and approximately 10 months after the workshop (delayed post-test) using a previously validated instrument known as the Food Irradiation Teacher Assessment (*FITA*) (Thompson et al., 2006). The assessment compared six constructs (or scales) of attitudes and knowledge towards food irradiation. The constructs included teachers' (a) attitudes about safety of food

irradiation (*Safety*), (b) attitudes toward learning about food irradiation (*Learning*), (c) self-perceived competency in teaching about food irradiation (*Competence*), (d) level of concern regarding risks of foodborne illnesses in the United States (*Foodborne Illness Risk*), (e) level of understanding about food irradiation (*Understanding*), and (f) knowledge of food irradiation (*Knowledge*).

Descriptive statistics from the pre-test revealed that Texas family and consumer sciences teachers held neutral to positive attitudes towards the safety of food irradiation (*Safety*), positive attitudes regarding learning about food irradiation (*Learning*), greater than average concerns regarding the risk of foodborne illness (*Foodborne Illness Risk*). Teachers held negative attitudes regarding their ability to teach about food irradiation (*Competence*) and their perceived level of understanding about it (*Understanding*).

The influence of prior knowledge and attitudes is well documented in science education (e.g. Chinn & Brewer, 1993; Chinn & Brewer, 1998). Strongly held prior knowledge and attitudes that are inconsistent, incorrect, or “naïve” can be considered a misconception (Driver & Easley, 1978; Hasan, Bagayoki, & Kelley, 1999). These misconceptions can obstruct an individual’s learning and understanding of complex science and technologies. The food irradiation workshop in this study was designed to provide a diversity of experiential learning regarding the biological and physical sciences surrounding food irradiation technology and to address potential food irradiation misconceptions.

The post-test, administered immediately following the workshop, showed statistically significant increases on five of the six scales, suggesting an immediate impact associated with the workshop. In concert with the findings of earlier food irradiation educational research (Bruhn, 1998; Eustice, 2004; Pohlman et al., 1994; Thompson et al., 2004; Thompson & Knight, 2006b), these data revealed significantly positive increases regarding teachers’ attitudes toward safety of food irradiation (*Safety*), their perceived level of understanding about food irradiation (*Understanding*) and their ability to teach it (*Competence*), their knowledge of food irradiation (*Knowledge*), and heightened concern regarding the risk of foodborne illness (*Foodborne Illness Risk*). Teachers’ attitude towards learning about food irradiation (*Learning*) remained high immediately after the workshop, suggesting that teachers felt that education regarding food irradiation was important.

Data collected in the delayed post-test period substantiated results obtained immediately after the workshop, with teachers sustaining the statistically significant positive post-test increases in four of the six constructs. Teachers’ gains remained statistically significant in the *Safety*, *Competence*, *Understanding*, and *Knowledge* constructs. The delayed post-test revealed one attitudinal change that merits additional study. Teachers’ delayed post-test concerns about foodborne illness risk reverted to pre-test levels, indicating that the workshop heightened their concerns immediately, but had minimal long-term effect. Further study may reveal why teachers’ levels of concern for foodborne illness risk decreased during the time between the post- and delayed post-test. It would be beneficial to determine if teachers became less concerned about this issue over time, if they forgot the connections between *Foodborne Illness Risk* (caused from bacteria in meats, fruits, and vegetables) and food irradiation technologies, or if attitudes towards foodborne illness risk were strongly held beliefs that were influenced immediately but not long term, as has been documented for many strongly held science misconceptions (Chinn & Brewer, 1993; Chinn & Brewer, 1998).

Although we did not measure actual teaching behavioral change, it would be interesting to investigate the change in behavior regarding classroom teaching of food irradiation curriculum

following the intervention. Interestingly, previous educational research has indicated that teachers who have had experiences or education in certain subject matter, such as the biological and physical sciences, were more likely to teach those sciences than were their counterparts who had little knowledge or experience (Terry, 1990). Another worthy inquiry would be a similar study of students receiving this information from participating teachers.

Limitations

The results of our study suggest that the educational intervention (professional development workshop) was effective in helping to improve the knowledge of family and consumer sciences teachers and in positively changing their attitudes towards food irradiation; however, the study only included teachers in Texas. In addition, although participants were randomly selected, they self-selected to attend the workshop and therefore may have been more motivated to learn about food irradiation. Consequently, the results of this study should be viewed with limited generalizability. Additional studies are needed to confirm and extend the findings from this research.

Although the research findings suggest that participants made and sustained improvements in attitudes and knowledge after the workshop, other confounding factors may have existed. Because this study did not have a control group, other factors unknown to us may have contributed to those changes. In addition, a repeated measures design was used to assess both immediate and longer-term changes of participants. Since the *FITA* instrument was used to collect data at each time point, a memory or testing effect could have confounded the results. However, research has suggested that the largest testing effect occurs within two weeks and is of limited concern after one month (Cook & Campbell, 1979). Therefore, this external validity threat was minimized since each test administration was at least 2.5 months apart.

Implications

Family and consumer sciences teachers have the potential to reach multiple audiences, including students, administrators, and members of local communities. They have the unique opportunity to provide information about food irradiation so that individuals and families can make more informed choices regarding food irradiation. Our study suggests that professional development opportunities for family and consumer sciences teachers regarding food innovations, such as food irradiation, can improve their attitudes toward such innovations and potentially decrease any misconceptions they may have. In addition, these opportunities can increase FCS teachers' self-efficacy beliefs (attitudes) regarding their understanding and their competency to teach about new technologies or innovations (Thompson & Knight, in press).

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