Integrating Food Science into High School Agricultural Education in Tennessee

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Research type: Quantitative
Research Priority Area: School-based Ag. Education

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One in six Americans is affected by foodborne illnesses, but agricultural education can reduce such instances. Raw and undercooked poultry and eggs are often associated with foodborne illnesses. Educating consumers about the safe handling of poultry and eggs is an important component of reducing foodborne illnesses. Secondary agricultural education can help with this issue. In Tennessee there are a number of pathways and courses integrating food safety/science in high school agricultural education programs, and a new pathway, Food Science and Safety. It is important to assess teachers' integration of food science and their desire to teach in the new pathway. It is also important to understand teachers' current food safety knowledge. We assessed teachers' reported importance ratings and ability levels for certain food safety practices to identify potential training priorities. According to the assessment, teachers need the most professional development in the areas of "safely transporting packaged food products to market," "creating a clean and safe environment for slaughter and packaging," and "safely storing packaged food products while at market." Teachers also indicated that food safety lessons could be incorporated into existing pathways in secondary agricultural education.

Introduction

The Centers for Disease Control (CDC) estimates that approximately one in six Americans, or approximately 48 million people, will be affected by foodborne illnesses yearly. Approximately 128,000 of these people are hospitalized and 3,000 people die (Centers for Disease Control and Prevention, 2016). Most foodborne illnesses are caused by eight known pathogens. *Campylobacter* and *Salmonella* pathogens are in the top five of the pathogens that cause humans to become sick, hospitalized or die (Centers for Disease Control and Prevention, 2016). The United States Department of Agriculture's Food Safety and Inspection Service has found that raw and undercooked poultry and eggs are often associated with *Campylobacter* and *Salmonella* (2015). However, agricultural education can do its part to reduce these instances by educating youth and consumers on how to reduce their risk of foodborne illness from *Campylobacter* and *Salmonella* pathogens by safely purchasing, storing, handling and preparing poultry products and eggs.

Historically, students were taught new agricultural practices by participating in youth clubs (i.e. Corn Clubs, FFA, 4-H) with the goal that they would share their knowledge with their parents (Urichio, Moore, & Coley, 2013). When youth demonstrate the success of learning a farming practice, adults are more likely to adopt the practice (Rasmussen, 1989). This same concept can be used in high school agricultural education and food safety lessons. Students in agricultural education can share what is learned in the classroom about food safety knowledge and practices with their families, friends and others.

The Poultry and Egg Education Project (PEEP) is a USDA-funded, research-based educational program that produced a curriculum comprised of consumer-focused, impactful messages addressing poultry and egg safety practices (Godwin & Ricketts, 2018). The intention of the PEEP curriculum was to inform and educate consumers how to better store, handle, and prepare raw poultry and eggs to reduce illnesses and deaths from *Salmonella* and *Campylobacter*

(Godwin, 2015). Agricultural education in Tennessee has faced many recent changes, including those based on the integration of the Common Core Standards Initiative to the Complete College Tennessee Act. Agricultural education teachers in Tennessee cover a diversity of topics, from floriculture to poultry (Tennessee FFA, n.d.). It is important to use curricula that are relevant, rigorous and applicable in content, and by gathering feasibility data from teachers related to food safety courses, lessons, and integration, PEEP can focus its curriculum development.

The theoretical framework identified for determining agricultural education teachers' interests, intentions, and integration of food science/safety, specifically poultry and egg education, includes the Concerns-Based Adoption Model (CBAM) (Hall & Horde, 1987) and Ajzen and Madden's (1986) Theory of Planned Behavior (TPB). According to CBAM, teachers have concerns that need to be answered before they can adopt or make any other decisions about a particular curriculum or curriculum component. In fact, CBAM also posits that the teacher is the central figure in a complicated adoption-decision process. Validation research indicates "that successful implementation of [programs] depends on teachers' participation and comfort level of the initiative" (Mugweni, 2012, p. 78). According to TPB, teachers' behavior is directly influenced by their intention to perform the behavior, and their intentions are influenced by behavioral beliefs (e.g., positive or negative beliefs about integrating a food safety lesson), subjective norms, and behavioral control (e.g., perceptions about how well qualified a teacher might be to teach a certain food safety topic).

Purpose and Objectives

The purpose of this study was to determine agricultural education teachers' interests, intentions, abilities, and levels of integration in an effort to disseminate potentially life-saving information in the secondary agricultural education curriculum, specifically through the new Food Science pathway in Tennessee, but also through other pathways and courses not directly related to food science. The following four objectives guided this study:

1. Describe teacher interests and intentions regarding the new Food Science and Safety pathway being introduced by the state of Tennessee.
2. Identify current and expected ways that food science/food safety integration that could take place in current courses and topics being taught.
3. Describe teacher perceptions of the importance level of, and their competence in, teaching food safety practices, and identify the teacher education/training priorities of five food safety practices.
4. Identify types of teaching resources that teachers would most like to use if they integrated lessons on poultry and egg food science and safety.

Methods

The population being studied included all agricultural educators in Tennessee. Data were collected from educators attending the FFA Convention. This descriptive study utilized the survey research method. The researcher-developed instrument contained 20 items, including six items related to participants' current teaching experiences and views on food science pathways. There were five items related to food safety practices that teachers were asked to rank by

importance and then rank their own ability level in applying these practices. Level of importance was measured on a five-point summated rating scale (i.e. Likert-type), in which *1=not at all important, 2=somewhat important, 3=neither important nor unimportant, 4=somewhat important,* and *5=very important*.

Teachers' ability levels in these five food safety practices was also measured with a five-point scale, in which *1= not at all qualified, 2=somewhat qualified, 3=neither qualified nor unqualified, 4=somewhat qualified* and *5=very qualified*. Teachers were asked seven food-safety knowledge questions related to the proper handling and preparation of raw poultry and eggs in the home. Six questions were formatted as multiple-choice, and one question was true or false. Lastly, a demographic section collected data related to participants' gender, age, name of current school, years of teaching experience and number of students in the teachers' FFA chapter.

The instrument was checked and validated for face and content validity by faculty in the College of Agriculture with expertise in Food Science and Safety and Agricultural Education. Analysis was conducted at the item level so construct reliability was established for this researcher-developed instrument.

Upon Institutional Review Board (IRB) approval, researchers administered instruments in person at the state FFA convention and electronically via the university Qualtrics account. At the state FFA convention, we had an educational display related to food safety at the convention's career /trade show. When teachers visited the display, we asked them to complete the questionnaire. This approach did not yield a large enough portion of teachers in Tennessee, so the instrument was loaded onto Qualtrics Survey Software and an email was sent to teachers following the convention. A total of 89 educators completed the surveys out of a possible 339 teachers in the state. Data were analyzed using Qualtrics, Microsoft Excel, and IBM® SPSS® Statistics 24.0. Descriptive statistics conducted included mean-scale scores and standard deviations, frequencies, percentages, median and mean-weighted discrepancy scores.

Results

Teachers indicated that many of the courses they planned to teach should incorporate lessons pertaining to food safety. Some of these courses included: *Agricultural Science*, *Large Animal Science*, *Greenhouse Management*, and *Veterinary Science*. While most teachers expressed interest and felt qualified to teach the new Food Science pathway, there were others who failed to express an interest. The results also showed many teachers looked for and used a variety of educational resources related to food safety to integrate in their lessons.

The teachers' demographic background was reported as being majority male (*n*=55, 71%) and female (*n*=22; 29%). The mean age was 40 years old, and 14 was the mean for years of teaching experience. There were a total of 62 high schools represented from across Tennessee. The FFA chapters ranged in size from 20 to 375 members with a median member size of 88.

Teachers were asked to select, from a list of all known courses, the courses that they were currently teaching. They were also asked to select, from a list of all courses, the ones they thought could be related to food science and food safety. The most frequent course offered by

teachers in Tennessee was *Greenhouse Management* (*f*=38), followed by *Agriscience* (*f*=36), and then *Small Animal Science* (*f*=27). There were twenty responses noted as *other* for the question seeking to determine if current agriculture courses were being taught. Thirteen of these responses were categorized as *Agricultural Mechanics* and three of the responses were categorized as *Agricultural Engineering*. Five *other* responses were recorded as *Alternative Energy*, *Work-based Learning*, *Co-op*, *Floral Design*, and *Leadership*. Frequencies and percentages of all courses teachers were currently teaching are listed in Table 1 and ranked from highest to lowest frequency.

Table 1
Courses Taught by Teachers in the Current Year

Course	*f*	*%*
Greenhouse Management	38	49
AgriScience	36	46
Small Animal Science	27	35
Agricultural Power & Equipment	24	31
Veterinary Science	24	31
Livestock Management	23	29
Principle of Agricultural Science	22	28
Landscaping & Turf Science	21	27
Wildlife Management & Recreation	21	27
Other	20	26
Horse Science	18	23
Advance Principle of Agricultural Science	11	14
Forestry Management	11	14
Plant & Soil Science	11	14
Agricultural & Bio systems Engineering	8	10
Org Leadership & Com	8	10
Principle of Horticultural Science	8	10
Supervised Agricultural Experience	7	9
Floriculture	6	8
Intro to Agricultural Science	6	8
Agricultural Business & Finance	5	6
Aquaculture & Hydroponics	5	6
Advance Hydroponics	4	5
Agric. Food & Nat Resources	4	5
Animal Biotechnology	2	3
Plant Biotech	2	3
Advance Aquaculture Science	1	1
Exploring Agricultural Science	1	1
Principles of Agribusiness	1	1
Advance Principles of Meat Science	0	0
Agricultural Economics	0	0

In Table 2 a summary of teachers' responses when asked what courses they planned to teach during the coming school year is provided. They were again given the option of selecting from a list of courses all that applied. The course with the most frequent response was *Agriscience* (*f*=51). The next most frequent response was *Greenhouse Management* (*f*=36), followed by Large Animal Science (*f*=34). There were four responses reported as *other*, which included *Alternative Energy, Agricultural Engineering, Work-based Learning*, and *Introduction to GIS*.

Teachers were asked how interested they would be in teaching the new Food Science pathway. Half of the respondents indicated they were somewhat interested in the Food Science pathway (*f* = 39, 50%) followed by 21% (*f* =16) stating they were not at all interested. A total of 18% (*f* = 14) reported being somewhat interested and 12% (*f* = 9) were very interested.

Teachers were then asked how qualified they would be to teach the Food Science pathway. Thirty-three (43%) reported they were somewhat qualified, while 27 (35%) reported being somewhat unqualified. Nine teachers (12%) indicated they were very qualified, and eight (10%) indicated they were not at all qualified.

Table 2
Percentage of Courses Teachers Planned to Teach in the Coming Year

Course	*f*	*%*
AgriScience	51	68
Greenhouse Management	36	48
Large Animal Science	34	45
Small Animal Science	33	44
Landscaping & Turf Science	31	41
Veterinary Science	27	36
Principles of Agricultural Mechanics	25	33
Agricultural Power & Equipment	21	28
Org Leadership & Communication	16	21
Nat Resources Management	12	16
Principles of Plant Science & Hydroculture	12	16
Agricultural & Biosystems Engineering	11	15
Agricultural Business & Finance	11	15
Applied Environmental Science	11	15
Plant & Soil Science	9	12
Supervised Agricultural Experience	8	11
Agricultural Food, & Nat Resources	6	8
Principles of Agribusiness	6	8
Food Science & Safety	4	5
Introduction to Agricultural Science	4	5
Other	4	5
Principles of Food Production	3	4

Advance Food Science	2	3

Note. % is out of 75 respondents. There were 377 total responses.

Respondents were then asked which of the courses they believed could integrate lessons in food safety. *Food Science and Safety* received the most responses (*f* =71), with 92% of respondents choosing this course. *Advanced Food Science* received the second most responses (*f* = 67), with 87% of the respondents choosing this course. *Agriscience* received the third most responses (*f* = 65), with 84% of the respondents choosing this course (See Table 3).

Table 3

Teachers Who Believed Food Safety Could be Integrated (in each course)

Course	*f*	*%*
Food Science & Safety	71	92
Advanced Food Science	67	87
AgriScience	65	84
Agriculture Food & Nat Resources	61	79
Principles of Food Production	57	74
Large Animal Science	42	55
Intro to Agricultural Science	41	53
Greenhouse Management	33	43
Principles of Plant Science & Hydroculture	33	43
Veterinary Science	31	40
Plant & Soil Science	29	38
Supervised Agricultural Experience	27	35
Agricultural & Biosystems Engineering	24	31
Agricultural Business & Finance	22	29
Applied Environment Science	20	26
Principle of Agribusiness	19	25
Small Animal Science	18	23
Nat Resources Management	13	17
Org Leadership & Communication	12	16
Landscaping & Turf Science	4	5
Principles of Agricultural Mechanics	3	4
Agricultural Power & Equipment	2	3
Other	1	1

Note. % is out of 88 total respondents. There were 695 total responses.

Regarding poultry and egg food safety specifically, respondents were asked to rate the importance of key food safety practices, and their ability or competence in key food safety practices. Table 4 shows mean weighted discrepancy scores (MWDS) ranked from highest to

lowest, calculated to identify the areas of greatest need for professional development (McKim & Saucier, 2011). It was found that teachers have the most in-service needs for *Proper handling of raw poultry or eggs in the home to prevent transfer of harmful bacteria to other food/surfaces* (M=4.84 Importance; M=3.83 Ability) and *Creating a clean and safe environment for slaughter and packaging* (M=4.84 Importance; M=3.58 Ability). Using a thermometer when cooking poultry and eggs to determine if the final product is cooked completely and safely was indicated the lowest importance and ability by teachers.

Table 4
Importance, Ability, and Mean Weighted Discrepancy Scores of Food Safety Skills (n = 77)

Item	Mean Importance	Mean Ability	MWDS
How to safely transport packaged food to market	4.73	3.34	5.60
Creating a clean and safe environment for slaughter and packaging	4.84	3.58	5.31
How to safely store packaged food products while at market	4.79	3.53	5.21
Proper handling of raw poultry or eggs in home to prevent transfer of harmful bacteria to other food/surfaces	4.84	3.83	4.39
Using a thermometer when cooking poultry and eggs to determine if the final product is cooked completely and safely	4.52	3.74	3.22

In Table 5 there is a list of teachers' knowledge of relevant food safety practices related to poultry and eggs. Teachers were most knowledgeable of the importance of hand washing after handling poultry and eggs (99%) and of using a thermometer to determine whether or not whole chickens and turkeys are done, or safe to eat. However, teachers were less knowledgeable of the fact that a thermometer should also be used with ground turkey (67%) and egg dishes (33%). Ninety-two percent of the respondents knew that the bottom shelf of a refrigerator, with a plate or pan under the meat, was the safest place to store poultry. Teachers mostly (88%) understood that an appliance thermometer designed for refrigerators and freezers was the best way to ensure a safe temperature. Most (86%) also knew that the refrigerator was the safest way to thaw frozen poultry. Only 62% knew that 165 degrees Fahrenheit was the safe temperature for cooked poultry.

Table 5
Frequency (f) and percent (P) of correct responses by teachers to knowledge questions (n = 77)

Item	*f*	*%*
What is the best way to ensure the refrigerator is at a safe temperature?	69	88
When storing raw poultry in the refrigerator, is it best to store the product on the bottom shelf with a plate or pan underneath the packaging?	71	92
Which of the following is the safest way to store eggs?	59	76
After handling raw eggs or poultry, you should do what?	75	99
Which of the following listed below are safe ways to thaw frozen chicken before cooking?	66	86
Should a cooking thermometer be used on whole chickens or turkeys to	76	99

determine if the final product is cooked completely and safely?		
Should a cooking thermometer be used on chicken parts, such as breast or thighs to determine if the final product is cooked completely and safely?	61	79
Should a cooking thermometer be used on ground turkey to determine if the final product is cooked completely and safely?	51	67
Should a cooking thermometer be used on egg dishes to determine if the final product is cooked completely and safely?	25	33
The internal temperature of a poultry product should be (165 degrees F) to ensure it is cooked completely and safely.	46	62

Teachers were asked the question, "*When teaching food safety pertaining to poultry and eggs, which of the following educational resources would you like to incorporate into your lesson/lessons?"* Five choices were provided, which included: videos, written information, pictures, charts, diagrams and other. Video was the most popular choice (96%). A total of 78 respondents provided 354 responses to the question. There were 13 *other* responses for resources that would be helpful. Nine of the other responses were for additional forms of hands-on learning and demonstrations, and one response for HACCP training materials. Results are provided in Table 6.

Table 6
Teachers' Choices for Food Safety Educational Resources (n = 77)

Resource	*f*	*%*
Videos	75	96
Pictures	69	88
Written info	66	85
Diagrams	66	85
Charts	65	83
Other, please explain	13	17

Conclusions

Foodborne illnesses affect about 48 million people (Centers for Disease Control and Prevention, 2016). Raw and undercooked poultry and eggs are often associated with foodborne illnesses (USDA, 2015). Educating consumers about safe egg and poultry packages is an important method for reducing foodborne illnesses. While the topic is important for all to be aware of, our study shows that, at least in secondary agricultural education, courses related to food safety are not being taught. The Tennessee Department of Education supports educating students about the importance by adding a new pathway in Food Science to the state agricultural education curriculum. This will involve requiring high school teachers to teach food science and food safety.

This pathway has the potential to educate students about food safety, and ultimately reduce foodborne illnesses. But, when we asked teachers what courses they planned to teach, only five percent had plans to teach *Food Science and Safety;* only three percent planned to teach *Advanced Food Science*. More teachers indicated they would integrate the lessons and materials developed as part of this project into other courses. These findings support the Concerns-Based

Adoption Model (CBAM), which reports that teachers will have concerns that need to be answered before they can adopt or make any other decisions about a particular curriculum or curriculum component. It is important to understand teachers' concerns regarding new curricula in food safety skills and lessons so Tennessee State University and others involved in curriculum development in the state can help guide the discussion and develop curriculum to educate the public.

In addition to foods courses, teachers felt food science and food safety education could be best integrated into Agriscience and Agriculture, Food, and Natural Resources (AFNR), two introductory-level courses. Interestingly, there were no agriculture courses into which teachers felt food science/food safety could not be integrated.

In this study, agricultural education teachers indicated that many of the courses they planned to teach should incorporate lessons addressing food safety. Most expressed an interest in, and felt qualified to teach, the new Food Science pathway. They also felt that it was very important to incorporate different subject areas dealing with poultry and egg food safety into their curriculum. Agricultural education teachers are perfectly positioned to educate about food safety, as students often share what is learned in the classroom with family, friends and the community. While the United States' food supply is among the safest in the world, we must not forget that consumers are becoming increasingly concerned with the safety of the food supply as the number of food recalls and the related media coverage has increased (Williams-Whatley, Doerfert, Kistler, & Thompson, 2005). This type of social norm fits into Ajzen and Madden's (1986) Theory of Planned Behavior (TPB) pointing out that behavior is directly influenced by intention to perform the behavior, behavioral beliefs, and behavioral control. In other words, food safety is an area where Tennessee teachers can make a significant difference, given the findings of this study and the current social norms.

Related to the poultry and egg food-safety concepts that come from the bench science portion of our project, teachers had the greatest in-service training needs for "ways to teach their students to safely transport food to markets," "create clean and safe environments for slaughter and packaging," and "safely store packaged food products at market." Koundinya and Martin (2010) conducted a similar study to determine the food safety in-service educational needs of agriculture teachers in Iowa. They found that a majority of agriculture teachers reported a need for in-service education in general food safety. The teachers specifically reported the in-service education focus on foodborne illnesses, food safety, bacterial contamination, food irradiation, food processing and pesticide pollution. Once educators are knowledgeable on these topics, they are better positioned to educate their students.

The last objective was to determine which resources teachers thought would be most effective for sharing food safety knowledge related to poultry and eggs. "Videos" was the resource they thought would be most effective, which is good since a reported educational product for this project was the use of videos to support lesson plans.

Learning safe food practices at an early age is beneficial in the long run, and ensuring that all students receive food safety education is critical (Food and Drug Administration [FDA], 1998). Young people, especially, should be the target for education in agriculture because people tend to shape their perceptions at an early stage, and changing those perceptions becomes more

difficult later in life (Holz–Clause & Jost, 1995).

Recommendations/Implications

The goal of the Poultry and Egg Education Project (PEEP) was to develop a curriculum to educate consumers about poultry and egg food safety, thereby reducing the risks related to foodborne illnesses. High school agricultural education in Tennessee adoption of a new Food Science pathway will allow this opportunity. If the Food Science pathway utilizes the PEEP curriculum and lessons, teachers, students, and others may apply important information that could save their lives.

It is important for Tennessee State University professors to gain a better understanding of areas of concern in food science and food safety if agricultural education is going to make a significant contribution to reducing foodborne illness and death. Once these areas are identified, Tennessee University will have the opportunity to revise lessons that have been developed, or develop courses which will improve the preparation of current and future agricultural education teachers about food science and food safety.

To make more teachers aware of the Food Science and Safety Pathway, and to make them more aware of ways to integrate food science and safety in current pathways and courses, in-service education should be developed and disseminated via teacher workshops and video (live and archived).

Lastly, a replication study that seeks responses from the entire [state] agriculture-teacher population is needed to gain more information about their knowledge, intentions and ultimately, behavior related to teaching food science and safety, specifically those related to poultry and eggs.

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