ABSTRACT

DUTTA, MADHUMEETA. Food Safety Basics for Artisan Cheesemakers: An Online Food Safety Training Intervention for Artisan Cheesemakers across US (Under the direction of Dr. Clinton Stevenson).

The artisan cheese industry is growing, and artisan cheese has been popular among consumers in recent years. With growing demands and new economic opportunities, there are concerns about food safety awareness and food safety practices of artisan cheesemakers in the U.S. Food safety training plays a crucial role in safeguarding the food system and consumers' health. Hence, the current research was done to assess the food safety needs of artisan cheesemakers to develop, deliver, and evaluate a food safety training intervention that will improve artisan cheesemakers' knowledge and food safety skills and help them implement good manufacturing practices and other food safety protocols.

A thorough front-end analysis (needs, learners, context and content) was done by conducting an online needs assessment survey with the members of an artisan cheese food safety forum, interviewing three subject matter experts and five North Carolina artisan cheesemakers in their cheese-making facilities, and reviewing the articles published in literature to determine the current state of food safety and sanitation of artisan cheese facilities. The analysis also provided information about the demographics of artisan cheesemakers and their food safety requirements. According to the results of the front-end analysis, artisan cheesemakers may lack competencies in multiple basic food safety practices, and small and very small operations are unlikely to have food safety plans. Some of respondents reported that no food safety training opportunities are offered to cheesemakers in their regions. The front-end analysis revealed that a customized training program on food safety is required to educate artisan cheesemakers, especially those who are new to this business. Direct interviews with the cheesemakers also suggest that they

would like to have an online training that would be self-paced and easy to access. Based on the above front-end analysis, a training course on the basics of food safety for artisan cheesemaker was designed, developed, and implemented.

This food safety training was then evaluated to determine the learners' satisfaction with the training, knowledge gained, attitude, self-efficacy, intention to follow food safety protocols and practice, and changes made post-training. Ninety nine percent (n=132) learners liked the training and were satisfied with it. A retrospective pre- and post-test knowledge assessment determined that the training program resulted in knowledge gain. Post training, learners' experiential attitude, instrumental attitude, self-efficacy, and intention scores about food safety were high. It was also determined that the training program could not produce significant changes in practices and behavior. The learners were satisfied with and enthusiastic about the e-learning program but there was no significant knowledge gain for all five lessons ($p<0.001$). Self-efficacy, experiential attitude, instrumental attitude, and knowledge gain predicted food safety intention with $R^2 = 0.55$. Instrumental attitude was found to be the strongest predictor of intention in the regression model in which a 50% variance in the intended food safety behavior can be explained by instrument attitude. This suggests that the participants who took this survey had a strong belief in the importance of food safety for cheesemakers. In addition, 22% (n=16) of participants had changed or updated food safety practices and/or programs related to GMPs in their facility, 58% did not intend to change anything, and 20% intended to change in future.

Food Safety Basics for Artisan Cheesemakers: An Online Food Safety Training Intervention for Artisan Cheesemaker across US

by
Madhumeeta Dutta

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APPROVED BY:

Dr. Clinton Stevenson Committee Chair	Dr. Ben Chapman
Dr. Deniz Eservel	Dr. Dennis D'Amico External Member

DEDICATION

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BIOGRAPHY

Madhumeeta Dutta grew up in an industrial city of India with very little involvement in agriculture as a child. She got interested in food technology when she was exploring her options for her undergrads degree. The thought of making this world a better place to live in by producing affordable and safe food motivated her to purse her undergrads in food technology from UP technical University Agra, India. After her undergrads, she worked in a Dairy company "Sudha Dairy" for 3.5 years as deputy quality assurance manager. In Jan 2016, she joined North Carolina State University for Masters of Science degree in Food Science. Her positive experiences during this time working with Dr. Stevenson's team inspired her to pursue a career in Quality assurance and currently, she is working with Alamance foods as quality assurance supervisor.

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Thank you to everyone in “Stevenson lab” – Stephanie Maggio, Kristen Sangria, Dr. Jessica White, Kinsey Porter for helping me out with idea generation and implementation along the way and whenever I am stuck and giving me opportunity to laugh and grow together in these two n half years.

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CHAPTER 1

Food Safety Needs Assessment for the U.S. Artisan Cheesemakers

ABSTRACT

There has been tremendous growth (~2000%) in the number of artisan cheese facilities in the U.S. over the past four decades. Increased consumption of artisan cheese and the new requirements of Food Safety Modernization Act (FSMA) rules have necessitated the need to look into the food safety hazards associated with artisan cheese. In August 2015, members of artisan dairy forum achieved consensus that, due to time and money constraints of the artisan cheesemakers, an online self-paced training intervention would be a good way to educate artisans cheesemakers on basics of food safety. This study was conducted to determine the food safety training needs of small artisan cheesemakers in the US and to develop an intervention. This was based on the front-end analysis for the instructional design to help them produce safe and wholesome cheese for their consumers. A survey was sent to 85 individuals identified by the national artisan dairy forum with a response rate of 28% (n=24). Qualitative data were also collected through face-to-face interviews of five artisan cheesemakers of North Carolina.

It was found that overall artisan cheesemakers lack competencies in multiple basic food safety practices. According to the respondents of the survey, it is very likely to have a food safety plan for large and medium sized operations is high (n=14 and n=10, respectively), whereas, small and very small operations are very unlikely (n=12) to have food safety plans. The survey also suggested that the artisan cheesemakers have access to the internet (n=21) and use computer (n=21) and smartphone (n=20) for day-to-day use. It was found that 11.76% (n=2) of the respondents reported that no food safety training opportunities are offered to cheesemakers in their regions.

These results suggest that the artisan cheesemaking community may lack basic food safety knowledge such as GMPs, pertinent laws and regulation, and hence an online training course on food safety basics can help them improve their knowledge and skills.

INTRODUCTION

Artisan Cheese Industry in the United States

Farmstead and artisan cheese has become a popular commodity in the American household. Artisan cheeses are cheeses crafted by hand with minimal or no mechanization. Artisan cheese is an important part of the rapidly growing dairy industry and is sold locally or nationally through various channels including retail, restaurants, or farmers markets (D'Amico, 2017; Machado, 2017). These specialty cheeses are popular among consumers because of their unique taste and flavor (Bouma A et al., 2014; Paxson, 2010) To give a unique touch to hand-crafted cheeses, cheesemakers name their cheese something that reflects and accentuates its local provenance and characteristics (Robert, 2007).

The journey of American artisan cheese is not as old as its European counterpart, but in a short span of time, American made artisan cheese has become very popular in the U.S. The American artisan cheese movement began in the early 1980s when the cheese market was dominated by large processed cheese industries. Some dairy farmers with excess milk started making cheese and shared with friends and family, and these cheeses gained popularity leading to the growth of artisan cheese industry in U.S. (Paxson, 2010). This growth and popularity resulted in a steep increase in the number of U.S. artisan cheese operations in the last 35 years. Also, the size of the individual artisan operations has increased over the years due to an increase in profit and the expanding markets for artisan cheese. In 1980, there were just 30-32 cheesemakers in the U.S., and now, there are more than 900 (American cheese society report; 2016). Some of these family-owned businesses exist for multiple generations, while some are just a few months old. New artisan cheese businesses are continuously entering and exiting the

cheese market. Small and new artisan cheesemakers often face financial burden and do not make any profit in the initial years of set-up (Axtell et al., 2008).

Cheese Related Foodborne Outbreaks

In recent years, cheese related outbreaks and recalls have been reported. In a study conducted by Gould et al. (2014), 90 cheese related outbreaks were detected from 1998 to 2011. The affected cheeses were made from pasteurized and unpasteurized milk. In these 90 outbreaks, 1,882 illnesses, 230 hospitalizations, and 6 deaths were reported (Figure 1; Gould et al, 2014). Food safety risk assessment of cheese suggests that some cheese, like soft cheese (≥50% of moisture content), is high risk (Choi, et al, 2016) and with the increase in the number of the artisan cheesemakers, the risk of producing unsafe and contaminated cheese may have increased if those cheesemakers lacked food safety knowledge and proper sanitary conditions. However, researchers could not find any direct data to support this theory.

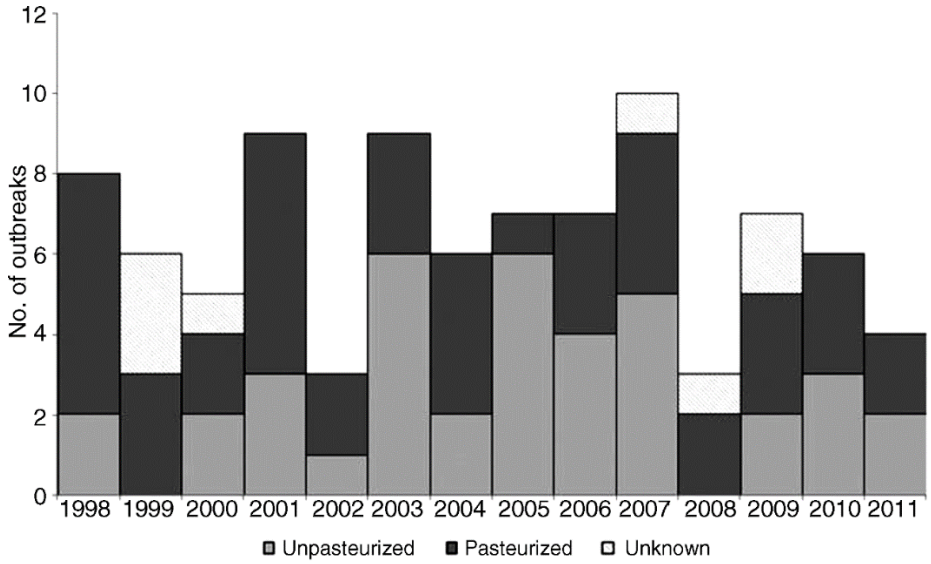

Figure 1. Cheese related outbreaks in the United-States (1998-2011), by year and pasteurization status (Gould et al, 2014)

Foodborne outbreaks lead to recalls and food related illness which pose serious financial loss to the artisan business, as well as consumer health concerns or even loss of life. Foodborne illness is a significant burden on the U.S. economy, costing $77.7 million every year (Scharff, 2012). Immune-compromised individuals like infants and children, pregnant women, the elderly, and those on chemotherapy, are more susceptible to foodborne illness. Foodborne illness not only includes symptoms such as vomiting, nausea or a stomach ache, it can also cause life-long chronic diseases, such as arthritis, kidney failure, or multiple organ failure, and in severe cases, death. Despite all the foodborne illness prevention efforts like increased surveillance systems with whole genome sequencing, stringent laws, and regulations, foodborne outbreaks continue to occur and claim lives in the United States. The number of foodborne outbreaks in recent years may have surfaced because of improved surveillance systems (Martin Wiedmann, 2015), the growing complexities of global trade, the emergence of new disease-causing organisms, changing consumption habits of consumers, and changes in methods of food production (Egan, 2006).

The Food Safety Modernization Act (FSMA) of 2011 required that all FDA-regulated products be manufactured with a food safety plan and preventive controls (FDA, 2013; Grover et al, 2016). These regulations require artisan cheesemakers to understand and follow changing food safety requirements or be forced to go out of business (D'Amico, 2017). Strained relations have between artisan cheesemakers and regulatory agencies have been reported as the cheesemakers fear inspectors and auditors (Machado, 2017). Sometimes, these strained relations signal an unfriendly relationship and lack of proper communication and collaboration between the two. Part of the problem is that cheesemakers may not know where to look for current resources and research related to the cheese industry to comply with required regulations

(personal interview with cheesemakers). Therefore, more transparent communication between cheesemakers and regulatory agencies is required. To help artisan cheesemakers flourish, there is a need to understand the cheesemakers' needs and challenges. A training program customized for small artisan cheesemakers will help them gain the required food safety knowledge, skills, and practice modifications to operate their businesses with confidence and comply with new FSMA regulations.

Instructional Design and Food Safety Training

To create new instructional training modules, it is important to follow a systematic science-based approach that includes these generic steps: analysis, design, development, implement and evaluation (ADDIE) (Larson & Lockee 2014). Analysis and evaluation are two important phases in the process of instructional design (Horton, 2003; Mavroudi, 2013). The analysis includes the following steps: (1) a needs analysis identifies the problem and the possible solution to the problem; (2) learner's analysis helps to know and understand the target learners and their learning requirements; (3) context analysis helps to understand the performance environment where the learners would learn and the environment where they would apply their new learning; (4) content analysis helps select the most relevant content for the training (Larson & Lockee, 2014). Yet, the analysis phase is often neglected in the development of training interventions, especially in e-learning projects (Mavroudi, 2013). This study revealed that only 17% of instructional designers conduct a full front-end analysis, which includes needs, learners, context and content, while the rest either do no analysis or perform a limited analysis.

Effective instructional design processes have been used successfully to develop learning instructions in various disciplines like education science, nursing, medicine, information

technology and so on. However, this science-based approach has not been extensively explored in the development of food safety trainings.

According to the World Health Organization (2000), employees of food industries or the food handlers were responsible for foodborne illnesses in the past by not following GMPs or food safety protocols. Food safety training informs the employees about food safety and its importance (WHO, 2000). Food safety education could help prevent foodborne illnesses; therefore, food safety education is important. The effectiveness of food safety education can be improved if trainings are based on front-end analysis during which a developer is informed about the needs and challenges of the learner, the target audience, and the context and content analysis (Kendall &Manson 2001; Neitengo, 2006). These trainings should be based on appropriate adult education theory like instructivism, constructivism, or behaviorism (Rhodes,1988; Nieto-Montenergo, 2007) with the application of various methods and activities to support easy learning, development of relevant skills, and to give hands on practice to the learners (Sergio Nieto-Montenergo, 2007). The training programs should be customized based on the needs and requirements of the target audience.

Most of the studies related to food safety training found in literature show how the training impacted the knowledge gains and behavior changes of the learners and were based on certain theoretical models like the Health Behavior Model (HBM), Theory of Planned Behavior (TPB), Integrated Behavior Model (IBM) etc. (Husain et al., 2016; Lillquist et al., 2005; Nieto-Montenegro et al., 2008; Soon & Baines, 2012; York et al., 2009), but none of the studies focused on how these training courses should be developed and designed based on a systematic science-based approach. Analysis and evaluation are the two major steps that can inform the design and development of effective instruction. Front-end analysis should be completed before

training design and development, and formative evaluation should be used to determine if the learning objectives of the training intervention were met. A summative evaluation should be used to determine training effectiveness and impact on learners. Analysis should be based on thorough front-end analysis (needs, learners, content and context); whereas, evaluation should be based on certain theoretical models like HBM, TPB, IBM, etc.

Currently, several food safety training opportunities are available to U.S. artisan cheesemakers at various locations in the form of face-to face workshops; however, these training classes are scattered in various states and do not follow a standard curriculum framework, which makes them un-unified, unaffordable and difficult for artisan cheesemakers across the U.S. to access (D'Amico, 2017).

PURPOSE

The purpose of this study was to perform a needs assessment on food safety issues of artisan cheesemakers to develop and design an effective training intervention that would coordinate, unify, and harmonize food safety training needs for artisan cheesemakers across the U.S.

METHODS

To develop a food safety training program for artisan cheesemakers across the U.S., a science-based instructional method based on the ADDIE model (Analyze, Design, Develop, Implement, Evaluate) was followed. A thorough front-end analysis was conducted to identify training needs and how training can address the problems of cheesemakers. These analyses were conducted through a mixed methods approach. To know about the artisan cheesemakers and their business, three subject matter experts were contacted and visited five artisan cheesemaking

facilities in North Carolina. An online survey was conducted with the members of artisan cheese food safety forum members and scientific research in the literature was reviewed.

Online Survey

An online survey was conducted to identify and assess the requirements of a food safety training programs for artisan cheesemakers. Survey questions (Appendix A) intend to assess the cheesemakers' competency level to perform various food safety related practices, their availability of technology (internet), devices (computer, smartphone, or tablet), and the chances of having a food safety plan in place. Qualtrics (Qualtrics, Utah) was used to develop and manage the survey. Participants' responses were kept secure by sending survey data over a secure encrypted connection. The survey received IRB approval (Protocol Number 6627) before being sent to the participants. This online survey was sent to 85 members of an artisan cheese food safety forum (August 2015, Providence, RI). The forum consisted of the following representatives: cheese producers/owners (n=14), food safety experts from land grant colleges associated with dairy training (n=20), distributor/retailer (n = 10), student (n = 10), consultant (n = 8), manager/quality assurance (QA) employee (n = 7), government representatives (n=2) and other (n=14). Not all the participants of the online survey were cheesemakers, but the other members have close association with the artisan cheesemakers through their occupation. Hence their perception about the artisan cheesemakers and their business can be helpful in knowing the target audience better. The survey link was distributed by email to the participants. Data was collected and analyzed in IBM© SPSS© Statistics Version 24.0 (2016). Cronbach's alpha was used to determine reliability of the questions under each of the constructs. Nineteen learning objectives were selected and given to the survey participants to rate in two different five-point Likert scales (very important (5) to not at all important (1), and very competent (5) to not at all

competent (1)) to gauge the importance of these learning objectives for artisan cheesemakers and how skilled they are in carrying out these competencies respectively. Face validity of the survey instrument was determined by giving the survey to five food science graduate students at NC State.

Communication with SMEs

Communication with three subject matter experts (SMEs) via email was conducted, and experts were asked about the demographics of cheesemakers and food safety challenges to operate an artisan cheese business (Appendix B). The criteria to choose the SMEs were those university experts who had worked extensively with the artisan cheesemakers and who are also food safety experts.

Visiting Artisan Cheese Facilities in NC

Five artisan cheesemakers (Appendix C) in North Carolina were interviewed between March 2016 to August 2016 by visiting their facilities to learn more about cheesemakers' daily activities and their food safety training requirements and challenges. Notes were taken while talking to the cheesemakers and a summary table was created based on common themes (Appendix C). Since these cheesemakers were from North Carolina so the observations and data may not be applicable across the industry and may not be a representative sample for all the cheesemakers in U.S.

Studying Peer-reviewed Articles on Artisan Cheesemakers and Food Safety

Data on the artisan cheese community were collected by reviewing the articles published in literature to determine the current state of food safety and sanitation of artisan cheese facilities and to learn more about the demographics of artisan cheesemakers and their food safety requirements. Peer-reviewed studies were found by searching databases like ScienceDirect,

Wiley Online Library, Emerald Insight, PubMed Central, ProQuest and International Association of Food Protection in the North Carolina State University electronic library website for the terms, “artisan cheese”, “artisan cheesemakers”, “food safety,” “food safety training”.

Statistical Analysis

Statistical analysis was done on the data of the online survey. All the importance scores and competency scores were averaged and analyzed separately. Since the data was not normally distributed so a non-parametric test Steel Dwass test was conducted to do a multiple comparison test to investigate if there was any significant difference between any of the importance scores by the nineteen learning objectives. It was also done with competency scores. Then the importance scores were compared to the competency scores within a leaning objective to identify any competency scores that are significantly lower than the importance scores within a learning at $p<0.05$.

RESULTS

Needs Assessment Survey

The response rate for this online needs-assessment survey which consisted of six questionnaires was 28% and self-reported occupation of the participants show that out of 28% respondents there were four artisan cheesemakers, four university professors, four retailers and rest participants didn’t choose any profession while responding to the survey (Figure 2). The coefficient of reliability (Cronbach's alpha) was greater than 0.78 for each question in the survey. Responses for each participant question are described in subsequent paragraphs.

Performance Gap

The learning objectives mentioned in the survey were rated ‘very important’ for the artisan cheese makers by the survey participants with an average score of 4.71 for all the

nineteen-food safety related learning objectives. On the contrary, when participants were asked to rate the same list of learning objectives on a 5-point Likert scale (very competent to not at all competent) to evaluate U.S. artisan cheesemakers' competency to perform those skills, the average competency score was 2.92. There was no significant difference in the important scores of the 19-learning objective when compared with each other except for learning objective "Process-related preventive controls (e.g. curd cooking, water activity, acidification etc.)" and "Implementing a food recall plan" and learning objective "Process-related preventive controls (e.g. curd cooking, water activity, acidification etc.) and "identifying informational food safety resources (e.g. regulation, bad bug books etc." at alpha <0.05. Similarly, no significant difference was found between the competency scores except for the following five pairs of learning objective: 1. "Supply chain preventive controls" and "Conducting a hazard analysis"; 2. "Implementing a food recall plan" and "Conducting a hazard analysis"; 3. "Process-related preventive controls (e.g. curd cooking, water activity, acidification etc." and "Supply chain preventive controls"; 4. "Process-related preventive controls (e.g. curd cooking, water activity, acidification etc." and "Implementing a food safety plan"; 5. "Implementing a food safety plan" and "Conducting a hazard analysis" (Table 2). The performance gap scores were obtained by subtracting competency scores from the importance scores but none of the gaps were significant at $p<0.05$ (Table 1). Although it was not statistically significant, according to the survey respondents, certain food safety topics (such as implementing a food safety plan, conducting a hazard analysis, identifying and interpreting food safety regulations, developing a food safety plan, implementing a food recall plan) revealed a larger performance gap; therefore, more emphasis should be given to such topics when designing the training course for artisan cheesemakers.

Likelihood to Have a Food Safety Plan for Artisan Cheese Operations

Most participants (90%) reported that large-sized artisan cheese operations (greater than 50 workers) had a food safety plan in their facility, 80% reported that medium-sized operations (16-50 workers) also had the likelihood of having a food safety plan, but 10% of respondents reported that it was very likely for small (5-15 workers) and very small industries (less than 5 workers) to have a food safety plan for their business (Figure 4). Since not all these respondents of the online survey were the artisan cheesemakers hence these results can be treated as the opinion of the participants about the artisan cheese community. According to the data collected through this survey small and very small artisan cheese operations need guidance to develop and implement food safety plans. Other researchers have also reported that food handlers in small food businesses lack a proper food safety control plan due to poor basic food hygiene and sanitation knowledge and limited resources. (Machado, 2017; Walker, 2003).

Accessibility to Internet and Availability of Internet Devices

The survey report showed that 57 % of respondents considered it extremely likely and 33% thought it was moderately likely that internet was available to artisan cheesemakers in U.S. Ninety percent of participants also considered that computers and tablets were available to the artisan cheesemakers (Table 5). As discussed in the method section, not all respondents were artisan cheesemakers but were closely connected to the artisan community through their profession. Hence in this study it is the perception of the survey participants that the artisan cheesemakers have access to internet and technological devices like computers, smart phones and tablets.

Availability of Food Safety Training Opportunities in the U.S.

Forty-one percent of respondents said two to three food safety training opportunities for artisan cheesemakers were available in their region in a year (Table 4). Twelve percent of respondents also said that there was no training opportunity available in their region and they were from California (San Diego county) and Washington (King county). They also self-reported their profession as consultants and retailer respectively. Demographic data shows that two of the respondents were from Vermont, three from New York, three from Pennsylvania and rest were from Texas, Georgia, Massachusetts, Rhode Island. Some food safety training opportunities for the artisan cheesemakers were available but were limited to certain places in the U.S., and they were localized. Therefore, it could be concluded that there is a need for unified training on food safety for artisan cheesemakers that focuses on food safety, risks associated with artisan cheese production, and how to minimize them across U.S.

Communication with the SMEs

According to Dr. Martin Weidmann majority of cheesemakers are white and more than fifty percent of them are females. Most of the owners of the cheesemaking facility have bachelor's degree but majority of them have limited food safety knowledge (Appendix B). According to Dr. Robson Machado the artisan cheese population in U.S. is very diverse and they have unique requirements e.g. in Pennsylvania most of the cheesemaker are Amish. Dr. Dennis D'Amico suggested that not much literature about the artisan cheese industry is available and that these businesses would fall under the FDA definition of very small business as having less than 500 employees. He also suggested that based on the number of employees working on the facility artisan cheese operations can be broadly divided into four categories very small (less than

five workers), small (five-fifteen workers), medium (16-50 workers) and large (greater than 50 workers).

Interview with the Cheesemakers

Three out of five cheesemaking facilities were three years and less than three years old and the fifth one was in business since 1995 (Appendix C). Eighty percent of these cheesemaking facilities have less than 5 employees working on their facilities and they use vat pasteurizer to pasteurize their milk. Five of the facilities use pasteurized milk instead of raw milk for cheesemaking considering raw milk cheese to be riskier. Three of these cheesemakers took food safety training from NC State while rest two owners said that they never took any food safety training course but were dependent on fellow cheesemakers and the inspector who visited their facility for the food safety knowledge and requirements. Fifty percent of those who took food safety training in workshop said that they were not satisfied with the training as they did not find it relevant to cheesemakers requirements. All the cheesemakers said they value food safety but struggle to keep them self-current with the changing regulations and how to comply with FSMA laws in coming years. They also requested to develop an online training on food safety specific to the cheesemakers that they can access at their convenient time. Listeria and environmental monitoring were the two most important topics for the cheesemakers and were interested to learn more about them. Four out of six cheesemakers reported to have a very slim profit margins and lot of resources are involved in setting up new business.

Table 1

Difference in Importance and Competency Scores

Learning Objectives	Average Importance score (SD)	Average competency score (SD)	Difference in importance and competency scores
Implementing a food safety plan	4.75(.52)	3.57(.82)	1.18
Conducting a hazard analysis	4.75(.52)	2.50(.71)	2.25
Identifying and interpreting food safety regulations	4.46(.71)	3.29(.79)	1.17
Developing a food safety plan	4.63(.70)	3.08(.76)	1.54
Implementing a food recall plan	4.96(.20)	3.33(.69)	1.63
Developing a food recall plan	4.88(.44)	2.63(.99)	2.25
Environmental monitoring	4.88(.33)	3.13(.73)	1.75
Food safety training program for employees	4.42(.81)	2.96(.62)	1.46
Identifying informational food safety resources (e.g. regulations, Bad Bug book etc.)	4.96(.20)	3.21(.96)	1.75
Assessing examples of Good Manufacturing Practice	4.58(.49)	2.83(.85)	1.75
Supply chain preventive controls	4.50(.76)	3.46(.82)	1.04
Sanitation preventive controls	4.75(.52)	2.67(1.07)	2.08
Identifying the various biological hazards	4.63(.56)	2.96(.89)	1.67
Outlining the basic components of a food safety plan	4.75(.43)	2.67(.94)	2.08
Identifying various chemical hazards	4.83(.37)	2.63(.99)	2.21
Allergen preventive controls	4.75(.60)	2.71(.98)	2.04
Explaining the importance of food safety	4.79(.50)	2.67(.94)	2.13
Table 1 (continued)			
Identifying various physical hazards	4.88(.33)	2.79(1.08)	2.08
Process-related preventive controls (e.g. curd cooking, water activity, acidification etc.)	4.33(.69)	2.42(.95)	1.92

Note. (n=24). Importance score was measured with a five-point scale ranging from Very important (5) to Not at all important. Competency was measures with a five-point scale ranging from Very competent (5) to Not at all competent (1). Difference in importance and competency scores denotes the performance gap.

Table 2

Comparison of learning objectives by importance scores, competency scores and gap scores

Learning objective scores (>/<) Learning objective scores *	Score Mean Difference	Std Err Dif	Z	p-value
Imp 19 (Process related preventive controls) < Imp5 (Implementing food recall plan)	-12.08	3.2	-3.7	.0218
Comp11 (Supply preventive controls) > Comp2 (Conducting hazard analysis)	14.0	3.8	3.6	.0322
Comp5 (Implementing food recall plan) > Comp2 (Conducting hazard analysis)	13.4	3.7	3.5	.0436
Comp19 (Process related preventive controls) > Comp11 (Supply preventive controls)	-13.8	3.8	-3.5	.0405
Comp19 (Process related preventive controls) > Comp1 (Implementing food safety plan)	-14.7	3.8	-3.8	.0187
Comp2 (Conducting hazard analysis) < Comp1 (Implementing food safety plan)	-14.9	3.8	-3.8	.0130

Note: * these constructs are significantly different at alpha=.05

Table 3

Likelihood of Having a Food Safety Plan in Artisan Cheese Facility

Artisan Cheese Operations	Food safety plan
Very small (<=5employees)	Very unlikely (n=16)
Small (5-15 employees)	Unlikely (n= 12)
Medium (16 – 50 employees)	Very likely (n= 19)
Large (> 50 employees)	Very likely (n=22)

Note. Total number of response n=24

Table 4

Availability of Food Safety Training in Different Regions of the U.S.

Number of Food Safety Training	Response Percentage location wise
More than 6 times a year	**5.88%** [New York]
4-6 times a year	**29.41%** [Michigan, New York, Pennsylvania, Wisconsin]
2-3 times a year	**41.18%** [Vermont, Pennsylvania, Oregon, New York, Rhode Island]
Once a year	**11.76%** [Texas, Washington]
Never	**11.76%** [California, Rhode Island]

Note. n=17

Table 5

Technology Available for Training

Devices	Percentage response
Computer	96%
Tablet	68%
Smart phone	92%

Note. Total number of response n=24

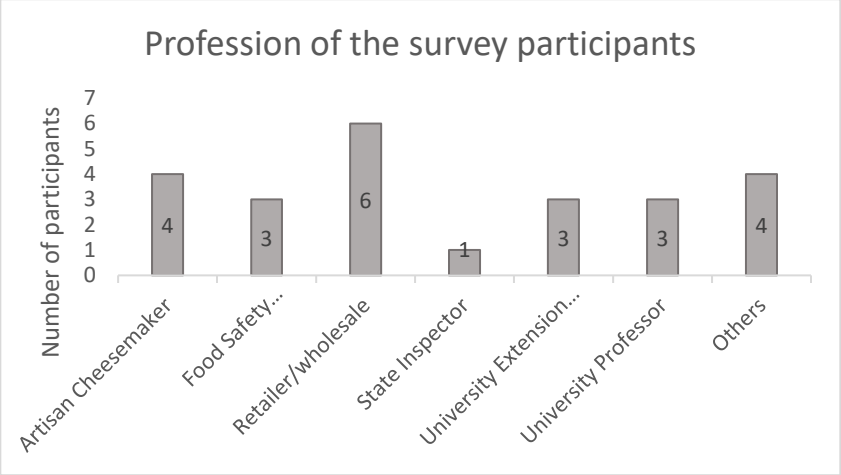

Figure 2. Self-reported profession of the online survey participants (n=24)

DISCUSSION

Needs Analysis

Risk factors associated with artisan cheese. Dairy products accounted for more foodborne-illness hospitalizations over an eleven-year period than 16 other commodity foods (Painter et al, 2013). Cheese is one of the most popular dairy products, and in recent years, several cheese-related foodborne diseases have emerged (Scharff, 2012). Certain factors can make dairy products like cheese riskier in terms of food safety hazards. Some of these high-risk factors are: (1) composition and intrinsic factors of certain cheese, (2) use of raw milk, (3) limited resources in terms of time, money, and labor, (4) lack of a food safety plan in small facilities, and (5) higher chances of post-pasteurization contamination. Each of these risk factors is described below in detail.

High water activity and relatively high pH in some cheese (e.g. soft cheese like Feta, Brie, Camembert, Blue veined cheese, Queso Blanco, etc.) favors growth of microorganisms, some of which may be pathogenic (Schmidt, 2015). Soft cheese when produced in an improper sanitary condition has a higher chance of being contaminated with pathogens (Gould et al., 2014). Some artisan cheese facilities lack proper cleaning and sanitation procedures in their facility (D'Amico, 2017; Lee, 2014, Machado, 2017). Strict sanitation practices can extend the shelf life of cheese and prevent contamination by minimizing spoilage that causes mold and pathogenic microorganisms prior to packaging. The primary reasons for not following proper sanitation and food safety practices were lack of food safety training and education, lack of capital, and time constraints (D'Amico's, 2017, personal interview with cheesemakers). Survey results show that it is very unlikely for small (n=16) and very small (n=12) artisan cheesemaking operations to have a food safety plan in place (Table 5). It is important to have an effective food

safety control program for every food manufacturing operation to prevent food contamination and safeguard consumer health. A food safety control program mainly consists of a Hazard Analysis and Critical Control Points (HACCP) plan, Sanitation Standard Operating Procedures (SSOPs), and Current Good Manufacturing Practices (CGMPs).

Approximately 38% of artisan cheese products in the U.S. are made from raw milk, and raw milk is a carrier of potential pathogens (Donnelly, 1990; Jayarao et al., 2006; Machado 2017; Van Kessel et al., 2004). According to the CDC, about 79% of outbreaks in the U.S. occur because of the consumption of raw milk or cheese made from unpasteurized milk. The rate of outbreaks caused by unpasteurized milk and products made from unpasteurized milk was 150 times greater than outbreaks linked to pasteurized milk, according to a study by the Centers for Disease Control and Prevention (CDC, 2012). In the U.S, it is legal to sell raw milk cheese if it has aged for more than 60 days and at a temperature greater than 35 degrees Fahrenheit (Machado, 2017). However, studies have shown that this 60 days of aging is not always sufficient to eliminate all pathogenic microorganism (D'Amico, 2008).

There is some risk associated with artisan cheese even if the milk is pasteurized. Improper pasteurization or post-pasteurization contamination in the dairy industry are a major contributor to food safety hazards which may include contamination through personal hygiene, cross contact surfaces, or through biofilms (Olsen, 2004; Painter, 2013). A primary reason for higher cross-contamination of artisan cheese is that 70% of artisan cheese facilities are adjacent to farms where there is no or very limited control over the movement of farm animals and workers (Kersting et.al, 2010; Todd, et al, 2007). Artisan operations also involve human elements in its processes that increase the risk of post pasteurization contamination. The air quality, equipment design, and sanitation practices of a facility play a major role in the risk or

likelihood of post-process contamination. Smaller and newer operations may lack the capital needed to take full advantage of what is most current or deemed best practice (Taylor, 2001; interview with the cheesemakers).

Cause of outbreaks. Pathogenic bacteria can cause foodborne outbreaks and can cause diarrhea, vomiting hepatitis A/B, and listeriosis. Four primary pathogens have been identified for most cheese related outbreaks: *Listeria monocytogenes*, *Salmonella enterica* serovar Typhimurium, *Escherichia coli* and *Staphylococcus aureus* (Griffiths, 2000; Langer et al., 012). Contamination of Ready-To-Eat foods like cheese with pathogenic organisms like *Salmonella* and *Listeria* is mainly due to cross-contamination in the processing facility, and it is one of the reasons for foodborne illness outbreaks (Ferreira et.al., 2014). Studies have shown that *Salmonella* and *Listeria* outbreaks, which are common in small cheese processing facilities, are mainly due to the use of raw milk, but environmental sources of *Salmonella* and Listeria *monocytogenes* might also pose food safety risks through cross-contamination (Beno, 2016). Some of the major cheese-related outbreaks reported by the CDC in recent years in the U.S. include: (1) a multistate outbreak of listeriosis linked to Crave Brothers farmstead cheeses in 2013 in which 6 people were hospitalized, one died, and one had a miscarriage; (2) a multistate *Listeria* outbreak in Vulto cheese, NY in 2016 where 6 people were hospitalized and 2 people died; (3) a multistate outbreak of listeriosis in imported Frescolina Marte brand ricotta salata cheese in 2012 where 22 people were hospitalized and 4 died; (4) a multistate outbreak of listeriosis among pregnant women (October 2008-March 2009) by the intake of Mexican-style cheese made from pasteurized milk (Jackson et al., 2011). In addition, there was another Mexican-style cheese-related outbreak of listeriosis in North Carolina in the U.S. between October 2000 and January 2001 (CDC, 2001). Recently, the CDC (2014b) announced a

multistate listeriosis outbreak caused by cheese products in California and Maryland. This outbreak affected eight individuals: seven were hospitalized, and one died. A detailed list of all major recalls of artisan cheese are provided in Appendix D. In these incidences, the cheese was contaminated during the cheese-making process. Some of these pathogens can survive for years in the dairy processing facilities, thereby increasing the chances of contamination (Meittinen et.al., 1999; Unnerstad et.al., 1996).

All risk factors analyzed in the above paragraphs show that the microbiological food safety implications are high in dairy products like artisan cheese. Needs analysis indicates that there is a performance gap, which can be closed by effective and affordable instruction. A food safety training that focuses on food safety hazards related to cheese, microorganisms associated with milk and milk products, prevention of growth of pathogenic organisms, and cross-contamination in the cheese are required. The goal is to develop and design a customized instruction that would change the focus of artisan cheesemakers from just making cheese to making safe quality cheese for consumers.

Target Audience

The artisan cheesemakers' population in the U.S. is diverse, ranges from young to old, and includes both males and females from various backgrounds such as science, art, and business (Paxson, 2010; Roberts, 2007; email communication with Dr. Martin Weidmann). The majority of artisan cheese facilities are small and family-owned (Machado, 2016; Roberts, 2007). Some cheesemaking establishments have been in business for generations, and some are relatively new. The artisan cheese society survey report from 2016 shows that two of these cheese companies were in business prior to 1900, but across the U.S., the median length of time in operation is 9-10 years. Younger businesses are regularly entering while some businesses are exiting the market

(ACS report; 2016). Variations exist in the size of these artisan cheesemaking facilities in terms of number of employees and production volume. There is no standard way to categorize artisan cheesemakers, but they can be broadly divided into four categories: very small scale (less than five workers), small scale (five to 15 workers), medium scale (16 to 50 workers), and large scale (more than 50 workers) (email conversation with Dr. D'Amico). Similarly, artisan cheesemakers' production volume is far smaller than commodity producers. Seventy-four percent of cheesemakers indicate annual production volume of 50,000 lbs. or less, and only 5% indicate production over one 1,000,000 lbs. per year. Needs assessment surveys indicate that small and very small sized artisan cheese operations might lack a food safety plan for their facility when compared to medium or large sized operations. Therefore, the requirements and specifications of training material might differ among cheesemakers as the larger and medium-sized facilities might be current and compliant with the food safety needs and regulation (D'Amico, 2017). For example, large and medium-sized companies can afford to train their employees on FSMA and can hire full-time PCQI personnel for their facility; whereas, limited resources make it a challenge for small companies to be compliant with the changing regulations.

After talking to various cheesemakers and subject matter experts, it was found that artisan cheese owners, employees, and part-time workers have different levels of education from high school degrees to PhDs, and they lead busy lives by completing multiple tasks like milking the animals, making cheese, going to farmers' markets to do their business, and managing sales and customers' orders (personal interview with artisan cheesemakers). Most artisan cheesemakers are somewhat aware of food safety issues but may not be confident about the implementation process of a food safety management plan in their facility (interview with cheesemakers). In Table 1, needs assessment survey results show that the competency scores for various food

safety topics for artisan cheesemakers are low; whereas, the knowledge about these food safety topics are high. The difference in the score can give an idea of the gap in competency level.

Most cheesemakers have learned the art of cheese making from family or friends or have learned through on-the-job training; therefore, they may lack a scientific approach to food safety. Interviews with cheesemakers revealed that they enjoy making cheese but also worry that, despite their hard work and love for their profession, they should not make their consumers sick. These findings support the demographic profiles of the cheesemakers mentioned in the other studies (Machado, 2016). Cheesemakers know how to make cheese but may lack the knowledge of food safety and the risk associated with it. These findings reveal a growing need for employee food safety training; however, companies may have little time or money to invest in training.

Therefore, an online training should be developed to provide an overview of food safety knowledge related to cheesemaking. Cheesemakers have different educational backgrounds; therefore, the material should be easy to understand, and the training should be interactive so that the training is interesting and effective for everyone. In addition, the training should be relevant to the needs of cheesemakers. Finally, training should be online, asynchronous, and self-paced to meet cheesemakers' needs for efficiency and time management.

Context Analysis

The performance environment of the target audience is their cheesemaking facility. Performance environment refers to the environment where new knowledge and skills are to be used (Larson & Lockee, 2015). The main challenges of the target audience in implementing food safety practices is lack of resources and lack of proper information about food safety and sanitation (D'Amico, 2017; Machado, 2017). Interviews with cheesemakers showed that a proper and effective food safety training can narrow this gap. However, limited resources in terms of

time and money may create barriers for travel to training centers/workshops. Therefore, a web-based, self-paced training intervention on food safety would be an effective medium to learn food safety basics. Face-to-face training or workshops allow for hands-on practice, while online classes allow the freedom to complete the training from any location and at any pace. Studies show that online training for food safety is considered effective for increasing food safety knowledge among food handlers when compared with in-person training (Wallner et al., 2007; Wantland et al., 2004). Online modes of instruction or distance education can significantly increase knowledge gain as well as behavior changes among participants when compared to face-to-face or in-person teaching modes (McCarthy et al., 2007; Wantland et al., 2004.)

The online survey results also showed that 96% (n=23) of respondents thought that artisan cheesemakers across the U.S. had access to the internet and could complete web-based training courses on computers, smart phone, and tablets. The results are summarized in Table 5. However, these findings are not in accordance with the study done in Pennsylvania where cheesemakers wanted face-to-face on-location training compared to an online course (Machado, 2017).

Voiceover, video, images, and web-links can be used to make the web-based training more relevant and interesting to cheesemakers. Detailed and in-depth lessons on some important topics like biological food safety hazards, GMPs, preventive controls, and environmental monitoring will help small artisan cheesemakers increase their knowledge awareness about food safety matters. Knowledge-check questions in between lessons can create engaging learning experiences.

Content Analysis

The content or the subject matter for this training intervention is based on the needs assessment study, as well as a food safety slide deck developed by the Innovation Center (D'Amico, Innovation Center slide deck). The learning objectives of the training were identified by asking respondents of the online survey to rate the importance of a list of food safety topics (Table 1). Then, the participants were again asked to rate the competence level of the artisan cheesemakers in performing food safety skills in their facility for each of the food safety topics. The analysis of the data shows that knowledge of these nineteen-learning objective related to food safety is important to cheesemakers, and their average score was more than 4.71. On the contrary, competency scores (average score=2.92) were low compared to the importance score. A difference was calculated by subtracting both the knowledge score and competence score (Table 1). Based on the survey response and the needs assessment (D'Amico, 2017), artisan cheesemakers, especially the smaller and the newer cheesemakers, require a three phase comprehensive food safety training with three main objectives: (1) to provide the trainees with basic principles, specifications, and overview of Food Safety Hazards and Prerequisite Programs; (2) to train the cheesemakers in developing a Food Safety Management System for their own facility and; (3) to give them hands-on training in product sampling and environment monitoring (Figure 3). The proposed Food Safety program for artisan cheesemakers will be divided into three parts (phases) that take them from learning the fundamentals of food safety to developing customized food safety plans for each facility that receives training.

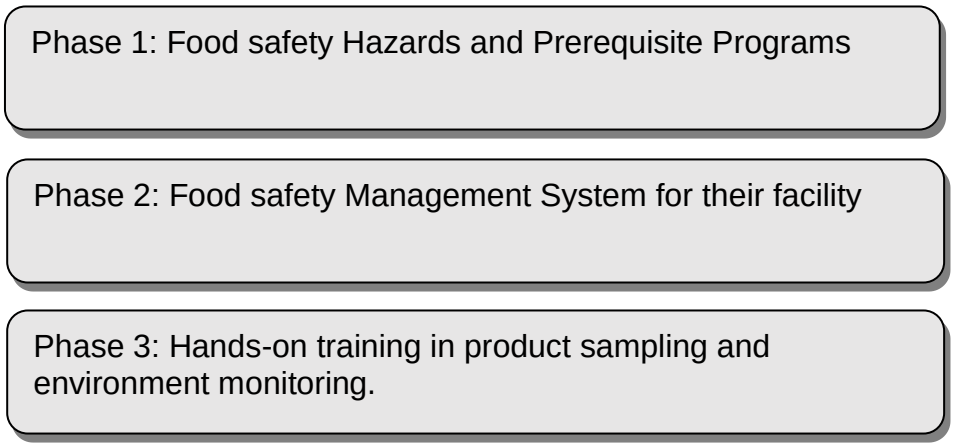

Figure 3. Proposed three phases of the food safety training for the artisan cheesemakers.

Phase 1

The first phase of the training will focus on the importance of food safety to artisan cheesemakers, important regulations and where to find them, common food safety hazards associated with artisan cheese, and knowledge about good manufacturing practices and environmental monitoring. At the end of level 1 training, the artisan cheesemaker will exhibit knowledge of foundational food safety concepts necessary to develop and implement a food safety plan. The first phase will be a self-paced online training course because this is a relatively easy and affordable way to reach a wide and varied audience across the United States. The program will be hosted at NC State University's Wolfware site (Moodle LMS). Content for the on-demand self-paced e-learning module will be based on survey results as well as a PowerPoint slide deck provided by the U.S. Dairy Innovation Center. This e-training module includes topics like foundational knowledge of food safety concepts and skills and will include five lesson plans: (1) Identify why food safety is important; (2) Locate pertinent laws and regulations; (3) Classify and recognize food safety hazards; (4) Identify GMPs in their facility; (5) Environmental monitoring and sampling introduction (Figure 4).

Figure 4. Phase one of artisan cheese food safety training

Each module will be interactive and easy to understand with professional voiceover, videos, pictures, interactive knowledge checks, additional links to resources for in-depth knowledge on certain topics, and quiz questions at the end of each lesson. A prototype of the design document of lesson 3 “Classify and recognize food safety hazards” and quiz questions for all the lessons are shared in Appendix H and Appendix I respectively.

Phase 2

In phase two, cheesemakers will learn to produce and maintain food safety plans for their own facilities in compliance with the Food Safety Modernization Act. At the end of level two training, the artisan cheesemaker will be able to draft a specific (customized) Food Safety Plan for their cheese facility and should be able to develop HACCP (Hazards Analysis and Critical Control Point) or HARPC (Hazard Analysis and Risk-Based Preventive Controls) plan. This training will be presented to the target audience across the U.S. through face-to-face workshops and will include interactive hands-on assistance to cheese producers.

Phase 3

In Phase 3, artisan cheesemakers will learn to implement and validate the Food Safety Plan. This process includes ongoing sampling, product testing, and environmental monitoring. This training would be in the form of workshops to give hands-on practice for product sampling,

testing, and environmental monitoring. With the proposed three-phased training interventions, the cheesemakers can improve food safety knowledge and competency skills, which will, in turn, help cheesemakers bring planned behavior change to create a safe and sanitary environment for cheese production.

CONCLUSION

There is a need to provide new and small artisan cheesemakers with food safety training on GMPS, preventive controls, and environmental monitoring, which will help them produce wholesome cheese by decreasing the number of recalls and foodborne outbreaks linked to artisan, specialty, and farmstead cheese. This can be done by designing and developing a customized, self-paced, interactive, and affordable web-based food safety training course for artisan cheesemakers.

The front-end analysis (needs assessment, learners' analysis, context analysis and content analysis) revealed that a customized training program on food safety is needed and that dividing the training into parts with "baseline" knowledge and moving to more specific and customized food safety plans would be a logical and successful approach. The artisan cheesemakers come from varied backgrounds, with some having been in the artisan cheese business for generations and some with little experience. The majority of artisan cheese businesses are small-scale and family owned. Approximately 38% of artisan cheesemakers use raw milk for cheese-making, and many cheese-making facilities lack basic cleanliness and sanitation. These facts coupled with the sweeping changes of the new Food Safety Modernization Act (FSMA) of 2011, which requires FDA-regulated products (including artisan cheese) to be manufactured with "preventive controls" and a written food safety plan in place, supports the idea of a well-thought-out approach to training. Furthermore, the front-end analysis revealed a lack of trust in food safety

legislation and enforcement officers, so a straightforward, streamlined, low-stress, easily accessible and relevant training is required to help artisan cheesemakers stay in business and keep consumers safe.

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CHAPTER 2

Evaluation of an Online Food Safety Training Program (Food Safety Basics for Artisan Cheesemakers)

ABSTRACT

An online training course for artisan cheesemakers across the U.S. on the basics of food safety was developed by following the principles of instructional design. The researchers then evaluated the effectiveness of this online food safety training program by measuring self-perceived knowledge gains of the participants, their attitudes toward food safety, intentions and self-efficacy related to cheese safety and quality, practice changes related to GMPs, preventive controls, and environmental monitoring. Participants of the training course took three different surveys. First, the participants were asked to report their self-perceived knowledge gain after completion of each of the five lessons. Second, they were asked about their attitude, intention, and self-efficacy toward food safety and their reaction to the training course, and the third survey asked them to self-report any practice changes related to GMPs and preventive controls after taking the training in their cheese making facility. The results demonstrated that the participants were satisfied with the training and enthusiastic about the e-learning program, and there was knowledge gain for all the five lessons but they were not statistically significant ($p<0.05$). Self-efficacy, experiential attitude, instrumental attitude and knowledge gain were correlated with food safety intention with $R^2 = 0.55$. However, instrumental attitude was found to be the strongest predictor of intention in the regression model in which fifty one percent variance in the intended food safety behavior can be explained by instrumental attitude. This suggests that the participants who took this survey had a strong belief in the importance of food safety for cheesemakers. However, results of the practice change survey showed that 22% of participants

had changed or updated their food safety practices and/or programs related to GMPs in their facility, 58% did not intend to change anything, and 20% intended to change in near future. The results from this study may serve as a reference for future evaluations of food safety-related training programs that will be taking place in phase 2 and phase 3 as proposed earlier in chapter one or any new study.

Keywords: Cheese, Cheesemakers, Training and Education, Food Safety, Sanitation

INTRODUCTION

Foodborne illness outbreaks and recalls are a concern for the food industry today. Frequent incidents of foodborne illnesses and recalls have posed a heavy burden on the economy. The total economic burden in the U.S. due to foodborne illnesses and recalls is more than $77.7 billion per year (Scharff, 2012). Several initiatives worldwide are being used to prevent foodborne outbreaks and recalls. These include increased surveillance and monitoring, appropriate employee training for preventive control, and the adoption of food-safety management systems and risk models (Husain, 2016). An effective food safety management system in a food processing industry addresses Good Hygienic Practices (GHP), Good Manufacturing practices (GMP), and Hazard Analysis Critical Control Point (HACCP) to encourage food safety (Jacxsens, 2009). Large and medium sized food companies have robust and effective food safety management systems compared to small scale industries like the artisan community (Machado, 2017).

It is paramount to any food company to ensure that all employees are aware of the food safety risk associated with processes and products. Through a proper and effective training, food handlers' knowledge and skills can be increased, which could potentially reduce food safety hazards and risk and thereby protect public health. A proper food safety training for the food handlers and the employees help them to make informed decisions regarding the best ways to implement knowledge and skills to comply with the legal requirements and adopt or follow best practices (Cohen et al., 2001; McElroy & Cutter, 2004; York et al., 2009).

Many food safety training programs are developed each year to meet regulation, legal requirements and educate food handlers and processors. However, not all training programs are being evaluated to analyze their effectiveness. Several studies have been done to evaluate the

effectiveness of food safety training programs in recent years (Egan et al., 2007; Gomes et al. 2014; Nieto-Montenegro et al. 2008; Nik Husain et al. 2016; Roberts et al., 2008; Soon & Baines 2012; York et al. 2009). Food safety training interventions are mainly developed to increase the food safety knowledge, skills, and attitudes of the food handlers toward food safety. In the long run, this increase in knowledge, skills, and attitude might help to change the behavior of the food handlers which will reinforce food safety. According to the Knowledge, Attitudes, and Practices (KAP) model, training leads to behavior changes (Thompson et al., 2005). Lately, however, many studies have shown that there are shortcomings to this model and that increase in knowledge gain does not always lead to behavior changes (Clayton et al., 2002; Seaman & Eves, 2006). Several studies have been conducted to explore the effectiveness of training on changing behavior, but these studies have conflicting results. Some studies support that training brings change in food safety practices (Adesokan et al., 2015; Cutter et al. 2004; Roberts et al., 2008), while other studies suggest that training does not influence behavior (Seaman & Eves, 2006). Several conceptual theories like The Theory of Planned Behavior (Ajzen, 1991), Tones Health Action Model (Tones, 1979), and The Health Belief Model (Janz & Becker, 1984) are used to understand human behavior in various domains. These theories differ in their construct, but fundamentally they all suggest that the behavior can be predicted by the learner's beliefs, attitude, norms, and intention.

Every year, training programs and interventions are developed to provide training and education in various fields, but only a few are properly evaluated to measure the effectiveness of these programs. Measurement and objective analysis are important to the effectiveness of the training. This process helps to improve the training and makes it more impactful for the learners (Kirkpatrick & Kirkpatrick, 1996). There are many ways to evaluate a food safety training

program based on program outcome (the number of program participants, number of programs delivered, and number of educational materials distributed) and program impacts (changes in knowledge or food safety behavior). Effective program evaluations identify if the target audience achieved intended learning outcomes such as those associated with knowledge, skills, and behavior.

Limitations to carry out these evaluations exist. Some of the major reasons are: a) lack of understanding and knowledge about how to measure program effectiveness, b) lack of resources like finances, staff, and time to conduct an evaluation, and c) difficulty collecting reliable data. It is important to gather actual data on food handler practices or processes to conclude if the training intervention is successful in changing the behavior of the learners (Mitchell, Fraser, & Bearon, 2007)..

Research Objective

This study explored the effect of the online training course "The Basics of Food Safety for Artisan Cheesemakers" on artisan cheesemakers in terms of their food safety knowledge, food safety attitude, intention and self-efficacy, level of learner's satisfaction in taking this training, and improvement of food safety practices.

METHODS

Kirkpatrick's model was used as a framework to evaluate this food safety training for artisan cheesemakers. Levels one through three of this model were analyzed to measure the learner's reaction toward the training, knowledge gained from the training with the help of retrospective pretest and posttest scores, attitude, self-efficacy and intention toward food safety, and what practice changes related to safety of cheese implemented in their facility after the training. This study adopted a qualitative and quantitative approach. All procedures used in this

study were reviewed and approved by the Institutional Review Boards for Human Studies at The NC State University (Protocol #12055).

The constructs of the theory of planned behavior were partially adopted to write the survey questions in this study. Before circulating the survey among the learners, all questions were face and content validated by the six subject matter experts from NC State and Connecticut State University. Based on the feedback, the structure and wording of the questions were revised. The reliability and validity of the different sections of the research instrument were determined through Cronbach's alpha and PCA factor loadings (Tables 5, 6, 7).

Before launching or implementing the training course, a beta test was conducted with the help of 25 participants who consisted mainly of stakeholders and the target audience. Feedback was collected in the form of a survey that had both Likert scale questions and open-ended questions related to the quality and accuracy of the content, the expectation of the learners from the course, the relevance of the content matter to the cheesemakers, and technical difficulties while accessing the course. Based on the feedback, actions were taken and errors were fixed before launching the training program nationwide.

Participants were asked to report their self-perceived knowledge change after each lesson. Retrospective pre- and post-test questionnaires were used as the principal measure of self-perceived knowledge gain. A traditional pretest and posttest method was not used to measure the participants knowledge gain because it was feared that pretest questions at the beginning of the training might deter the cheesemakers from taking this online training course. Hence retrospective questions were given to the participants in 5-point Likert scale ranging from very low - very high, asking the participants questions such as "What was your level of knowledge on

the following food safety topic before taking the course and what is your level of knowledge after taking the course?”

For the retrospective knowledge gains, the participant reported a pre- and post-response, and mean score and the standard deviations were calculated to determine the extent of knowledge on food safety topics before and after the program. The amount of knowledge level change reported was determined by subtracting each respondent’s pre-score from their post-score and then calculating the mean of the individual scores. For example, if an individual reported that the knowledge about whole genome sequencing before taking the training was medium and after the training it was high, then the change in knowledge was calculated as a one (high [4] – medium [3] = 1). The mean of the pretest scores were compared between the food safety topics to identify which food safety topics were significantly more or less known to the learners. Similarly, comparison of the mean posttest scores between food safety topics were done. Then, comparison of the pretest scores to the posttest scores within a food safety topic to identify any posttest scores that are significantly higher or lower than the pretest scores within a food safety topic. The Steel Dwass test was used to do the multiple comparisons.

Next, participants were asked for their learners’ reaction to the training, self-reported attitude, intention, and self-efficacy related to food safety once they completed all the lessons. There were six questions for the “learners’ reaction” section, and out of the six, two questions were open-ended questions where participants were asked about the strength and weakness of the training course. These open-ended questions were then codified based on the frequency of response and are summarized in Tables 2 and 3. After the learners’ satisfaction questions were completed, participants were asked if they were willing to reply to a few more questions related to attitude, self-efficacy, and intention.

This study used two different constructs to measure attitude as experiential attitude (phrased as “learning about food safety is extremely pleasing” to “extremely displeasing”) and instrumental attitude (phrased as “learning more about food safety will help me create a safer product” in the scale of “extremely likely” to “extremely unlikely”). Both experiential attitude (5 questions) and instrumental attitude (5 questions) were measured using the questions described in Table 6 after the participants completed all lessons. Self-efficacy questions were asked to estimate learners’ ability to perform specific tasks related to cheese safety. The self-efficacy survey had five questions and asked questions such as “Identify if the cheese you make is high risk or not.” These questions used a 7-point scale from “extremely certain I could not” to “extremely certain I could”.

Intention questions in this survey measured an individual’s interest or eagerness to carry out certain actions to achieve a goal. The survey questions measure participants’ intention, for example, one question asked, “To what extent do you intend to adopt proper cleaning and sanitation protocols to prevent cross-contamination?” A 5-point scale ranging from “Always” to “Never” was provided as answer options. The constructs related to attitude and intention each had five different questions, and the construct for self-efficacy had six questions.

Demographic questions ascertained the respondents’ gender, age, ownership of the facility, education, number of years in the cheese business, annual production, and type of milk used in cheese production.

The third set of questionnaires was given to the participants after one month of training completion to evaluate any short term self-perceived behavior changes. This survey was also voluntary. This survey consisted of 12 multiple choice questions. Each question was followed by an open-ended question. The first two questions asked the participants to state their role in the

artisan cheese industry and their annual cheese production volume per year. In the next ten questions, the participants were asked if they had changed any procedures/ practices in their facility (related to pest control, exterior grounds, construction or design of their facility, personnel health and hygiene, sanitary policies, equipment, material management, cleaning and sanitation, in -process testing, and environmental monitoring) and they had to choose from the following options: “yes,” “no, and I do not intend to,” or “no, but I intend to.” Participants were then asked to explain their answers based on what they chose. For example, if they choose “yes,” then they were asked to explain the changes they brought in for pest control since completing the course and why. Individual responses were collected, codified, categorized, and summarized (Table 11). Through self-report, the study measured what the learner thought about his or her own perspectives on certain issues or problems. Besides measuring accomplishments, problems and needs could also be measured for self-realization, which is important to self-improvement.

Statistical Analysis

The data collected were statistically analyzed using SPSS software version 24. Descriptive statistics were used to summarize the variables of interest, while and regression models were used to determine the relation between selected variables. Statistical significance was identified at a 95% confidence level ($P \leq 0.05$). Steel Dwass test was used to compare various means.

RESULTS AND DISCUSSION

Respondents (n=47) who participated in the online survey consisted of 66% and 34% female and male cheesemakers respectively. Cheesemakers could be categorized into one of the five age ranges: under 25 years (6%), 25 to 34 (17%), 35 to 44 (19%), 45 to 54 (28%), 55 to 64

(17%), or 65 years and above (13%) (Table 1). Education level also varied with eight percent reported to have a PhD, 15% had a master's degree, 49% reported having earned a bachelor's degree, 7% had an associate degree, 20% reported having a high school diploma. Thirty-four percent of respondents reported less than 1 year in the cheesemaking business; whereas, 26% had been in business between one to three years. Twenty three percent of the respondents reported they had been in the artisan cheese business for more than five years. Fifty seven percent of the cheesemakers used pasteurized milk for cheesemaking, sixteen percent reported to use raw milk for cheesemaking and the remaining twenty seven percent participants used a combination of pasteurized milk and raw milk for cheesemaking. This shows that most of the learners in this course are females between 25-65 years of age, and most of them have an educational background with a bachelor's degree. This course was developed mainly for new cheesemakers, but data shows that experienced cheesemakers also completed the training.

Table 1.

Socio-demographic of the Participants

Category	Sub-category	Frequency
Gender	Female	31(67%)
	Male	16(33%)
Age	Under 25 years	3 (6%)
	25–34 years	8 (17%)
	35–44 years	9 (19%)
	45–54 years	13 (28%)
	55–64	8 (17%)
	Over 64 years	6 (13%)
Level of education	High school or less	9 (20%)
	Associate's degree	3 (7%)
	Bachelor	23 (49%)
	Master's degree	7 (15%)
	PhD	4 (8%)
How long have you been working as a cheesemaker?	0-1 year	16 (34%)
	1-3 years	12 (26%)
	3-5 years	8 (17%)

Table 1 (continued)

	More than 5 years	11 (23%)
What is your annual cheese production volume per year?	5000 lbs. or less	30 (65%)
	5,001-10,000 lbs.	4 (9%)
	10,001- 20,000 lbs.	3 (6.5%)
	20,001- 50,000 lbs.	2 (4.5%)
	Over 50,001 lbs.	7 (15%)
What kind of milk do you use for cheese making?	Pasteurized milk for all cheeses	25 (57%)
	Raw milk for all cheeses	7 (16%)
	Combination	12 (27%)

Note: n= 47

Some of these demographic like gender, education level, experience etc. could affect food safety knowledge gain, attitude, self-efficacy and intention toward food safety. However, since the sample size was small, these demographic data could not significantly predict effect of food safety knowledge gain with higher education level or gender. Other studies conducted show that factors such as age, education or work experience may affect the level of food safety knowledge gain post training intervention (Angelillo, Viggiani, Rizzo, & Bianco, 2000; Pichler, Ziegler, Aldrian, & Allerberger, 2014). Since the sample size was small and the data were skewed toward the higher scores, these effects were not established in this study.

Learner's Reaction (Level One)

Ninety-seven percent (n=128) of participants responded to the survey that the training course met their expectations in terms of relevance of content and overall training quality. When asked if they would recommend this training to the other cheesemakers, 98% (n=130) responded "yes." The strengths and weaknesses of this training program highlighted by the participants were coded based on common themes and are summarized in Tables 2 and 3. Thirty-five percent reported that the training was interactive and engaging with the knowledge checks and quizzes, and 29% stated the additional links to various resources in the training modules were helpful.

Collectively, most of the participants responded that content of the training was educational, informative, detailed, easy to understand, modular, organized, and relevant to the dairy industry. Participants also liked that the course was self-paced, which gave them the flexibility to take it at their own convenience along with the links to important resources for more information and reference. Participants said that the voice-over, videos, and knowledge checks made the learning experience interactive and engaging.

Table 2

Themes identified for the strengths of the program

Strength of the program	Total Frequency
Educational, and informative content	9
Relevant, and comprehensive content to dairy industry	10
Easy to understand format	12
Modular and well presented	13
Effective voice over, videos and images	24
Self-paced and online	24
Additional links to important resources	38
Interactive and engaging knowledge checks and quizzes	46

Note: This frequency table was generated with the responses of 132 participants.

Table 3.

Themes Identified for the Weakness of the Program

Weakness of the program	Total Frequency
Lacks hands on experience	5
Lengthy training course	6
Lacks ability to download/print out course material	9
Lacks ability to ask questions or interact with instructor	9
Need to deep dive on specific topics	10
More practice problems and quizzes required	10
Audio-Video issues on browser	22

Note: This frequency table was generated with the responses of 132 participants.

When asked to describe the weakness of this program, participants said that they experienced some technical issues with some web browsers, and that they wanted more in-depth knowledge on certain topics like pathogens of concern, GMPs, and environmental monitoring. Several participants (n=22) of the online survey reported audio-video issues on the browser. Some (n=5) also said that the program lacked hands-on practice and that they also wanted the lessons in printed format so that they could review it later. To provide a better learning experience (based on the feedback given by course participants) future trainings will include more real-world context, authentic scenarios related to cheesemaking, spaced repetitions, and practice questions with feedback. Cheesemakers wanted more hands-on practice, which can be provided by including more case studies or scenarios relevant to artisan cheesemaking and then asking participants to make decisions or take actions based on their learning. This will provide hands-on practice of the knowledge that is gained from the training. Participants also reported that some lessons were lengthy and suggested to split the lengthy training into smaller chunks for better retention. Micro-learning can be incorporated by splitting the lengthy lessons into smaller lessons, which will further improve learners' retention. Spaced repetition training content will also help improve knowledge and skill retention. By adopting the methods like splitting the lengthy lessons into small lessons and putting activities in between the sections in a lesson, web-based training can be made more effective and interactive for learners (Thalheimer, 2017). Another, drawback of this training course was lack of an online portal where the cheesemakers can interact with the instructors and ask questions for clarification. However, due to a limited budget, this resource couldn't be provided. There is room for future improvements in the training by establishing a discussion forum section where the participants can ask any question or query related to cheese safety/training.

Learners' reactions provide direct feedback from the participants, but positive learner feedback does not ensure learning and practice change. However, negative feedback from the participants suggests lack of interest or attention from learners toward the training intervention (Baldwin, 1988; Phillips, 1997; Rouse D, 2011). In this study a regression model could be established between the learner's satisfaction and knowledge gain, instrumental attitude, experiential attitude, self-efficacy and intention score, but in this study, the sample size was too small to analyze any effect of learner satisfaction on knowledge gains, attitudes, intentions, behaviors, and practice changes.

Self-reported Knowledge Gain (Level Two)

The average retrospective self-reported pretest score for each lesson was 3.83(SD=0.70), 3.05(SD=1.18), 3.14(SD=1.40), 2.98(SD=1.36), and 2.69(SD=1.46) (Figure 1). Pre-test scores of the food safety topics were not statistically significant ($p<.05$). Although, higher pretest scores of 4 and above suggest that the participants were knowledgeable about these topics: "Importance of food safety for artisan cheesemakers", and "Why cheese is a high-risk product?" On the contrary, the following food safety topics with a score between 2 and 3 where 2 means low knowledge and 3 means an average level of knowledge: Frequency of environmental pathogen sampling and environmental pathogen monitoring. Artisan cheesemakers were aware of the changing regulations and the necessity of making safe cheese for their consumer; therefore, the self-perceived pretest scores were high. Environmental pathogen monitoring is important for all cheesemakers as FDA expects makers of RTE foods exposed to the environment to implement environmental monitoring (Luber, 2011). The low average scores for the knowledge about environmental monitoring shows that cheesemakers do

not feel confident about their knowledge of environmental monitoring and how to conduct them in their facility.

The average post-test scores were 4.19(SD=.63), 3.59(SD=1.18), 3.54(SD=1.47), 3.54(SD=.17), and 3.24(SD=1.6) (Figure 1). The mean scores of the posttest scores of the following food safety topics were higher such as “Importance of food safety for artisan cheesemakers,”, “Why cheese is high risk product”, “Whole genome sequencing and how it impacts your business” and “Retail consortium and where to look for other resources”

Table 4.

Average Pretest and Posttest Scores and Knowledge Gain with SD for each Food Safety Topic

Food Safety Topics for pretest and posttest	**Pretest scores**	**Post test scores**	**Knowledge gain***
Importance of food safety for artisan cheesemakers.	4.02(0.75)	4.36(0.67)	0.34
Why cheese is high risk product.	4.11(0.77)	4.33(0.71)	0.22
Whole genome sequencing and how it impacts your business	3.38(0.99)	3.88(0.81)	0.50
Relevant information in the Code of Federal Regulations for cheesemakers in terms of food safety.	3.02(1.23)	3.58(1.20)	0.56
Standards such as the (PMO) Pasteurized Milk Ordinance and the Food Code.	2.9(1.38)	3.5(1.19)	0.60
Retail consortium and where to look for other resources.	3.15(1.24)	3.7(1.23)	0.55
Categories of food safety hazards and categorize any given hazard into one of them.	3.09(1.5)	3.48(1.52)	0.39
Chemical food safety hazards in a cheesemaking facility	3.06(1.42)	3.53(1.47)	0.47
Physical hazards in a cheese making facility.	3.18(1.47)	3.55(1.49)	0.37
Factors that affect bacterial growth.	3.29(1.43)	3.59(1.51)	0.30
Four high risk biological pathogens typical in a cheese facility.	3.11(1.45)	3.58(1.50)	0.47
Areas in a cheesemaking facility that are high risk for pathogenic cross contamination.	3.11(1.44)	3.52(1.50)	0.41
Construction and design of a cheesemaking facility.	2.92(1.82)	3.26(1.54)	0.34
Personnel health and hygiene.	2.68(1.42)	3.47(1.62)	0.79
Sanitary facility and control (plumbing, water usage, sewage, etc.).	2.94(1.46)	3.29(1.60)	0.35
Equipment and design.	2.83(1.43)	3.44(1.61)	0.61
Pest control	3.09(1.40)	3.45(1.61)	0.36
Cleaning and sanitation.	3.17(1.41)	3.33(1.59)	0.16

Table 4 (continued)

Materials management (warehousing).	3.06(1.42)	3.39(1.59)	0.33
Food safety through Process Controls (cooking, acidification, aging, etc.	3.12(1.53)	3.55(1.58)	0.43
Environmental l pathogen monitoring.	2.62(1.58)	3.17(1.65)	0.55
The importance of environmental pathogen monitoring.	2.89(1.47)	3.301(1.66)	0.41
Environmental pathogen sampling zones in your facility.	2.64(1.49)	3.26(1.59)	0.62
Frequency of environmental pathogen sampling.	2.62(1.52)	3.20(1.61)	0.58
Corrective actions for an environmental pathogen monitoring program.	2.68	3.27	0.59

Note: n=66; * no significant knowledge gain

Figure 1. Average self-perceived knowledge score in each lesson for the retrospective pre-and posttest. Scale of 1(very low) to 5 (very high);
There is no significant difference between the pretest and posttest scores at ($p<0.05$).
n=66.

A multiple comparison of the mean scores of the posttest and pretest scores shows that there was no statistically significant increase in knowledge gain for each of the food safety topics (Table 4). There were no statistically significant gains in knowledge for each of the five lessons at alpha <.05 but the mean scores for the posttest were higher than the pretest score for each of the lesson. Based on the self-reported data, the cheesemakers had high scores on the importance of food safety for artisan cheesemakers and on good personal hygiene practices in both pre-and post-intervention as compared to other learning objectives. This is in accordance with the result found in other studies related to food safety training where there was significant knowledge gain post training intervention (Gomes et al. 2014; Nieto-Montenegro et al. 2008; Nik Husain et al. 2016; Soon, 2012).

Many previous studies have reported that the learners often overestimated their self-reported knowledge of food safety procedures because of either their optimistic bias or because of social (peer) desirability to comply when they self-report (Crandall, 2016; Tourangeau, 2000; Weinstein, 1980). Therefore, in this study, the results of retrospective pre-test and post-test results might be biased. To reduce the chances of bias, an assessment of actual knowledge gains should be done in the future.

Attitude, Self-efficacy, Intention

Cronbach's α for the different constructs (experiential attitude, instrumental attitude, self-efficacy, and intention) ranged from 0.78 to 0.96; whereas, the PCA factor loadings were higher than 0.31, which is within the acceptable range (Hair et al., 2010). Factor analyses suggest one factor for each of the scales for experiential attitude, instrumental attitude, self-efficacy, and intention as shown in Table (5-8). The average scores of the participants (n=41) for experiential attitude, instrumental attitude, self-efficacy, and intention are 5.99(SD=1.08), 6.68(SD=0.50),

6.43(SD=0.58), 6.63(SD=0.52) respectively on a 7-point Likert scale with 7 as a maximum score (Figure 2).

Table 5.

Mean, Standard Deviation and Factor Loadings for the Experiential Attitude about Food Safety.

Item questions	Mean	SD	Loading Factor
Learning about food safety is	5.63	1.13	.639
Following food safety rules is	5.71	1.29	.722
Applying Good Manufacturing Practices in my facility is	6.12	1.12	.831
Applying Process Controls in my facility is	5.98	1.11	.919
Implementing a program that monitors for pathogens in my cheese making facility is	5.95	1.20	.875

Note: Each item was paired with a seven-point scale ranging from Extremely displeasing (1) to Extremely pleasing (7)
Cronbach's alpha (α= .720) and PCA results (all items over 0.4 factor loadings) indicated acceptable reliability and validity, respectively.
n=41

Table 6.

Mean, Standard Deviation and Factor Loadings for Instrumental Attitude about Food Safety.

Item questions	Mean	SD	Loading Factor
Learning more about food safety will help me create a safer product	6.78	0.79	.526
Food safety regulations will keep my products safer from contamination	6.22	1.08	.746
Applying Good Manufacturing Practices in my facility minimizes food safety risk	6.76	.62	.606
Applying Process controls minimizes food safety risk	6.73	.71	.607
Implementing a program that monitors for pathogens in my cheese making facility will Keep my products safer from contamination	6.66	.82	.606

Note: Each item was paired with a seven-point scale ranging from Extremely unlikely (1) to Extremely likely (7)
Cronbach's alpha (α= .720) and PCA results (all items over 0.4 factor loadings) indicated acceptable reliability and validity, respectively.
n=41

Table 7

Mean, Standard Deviation and Factor Loadings for the Intentions about Food Safety in Cheesemaking.

Item Questions	Mean	SD	Factor Loadings
Follow personnel hygiene practices (frequent hand washing, no jewelry, wear hairnets and gloves while working) in your facility	4.88	0.51	.763
Adopt proper cleaning and sanitation protocols to prevent cross-contamination	4.90	0.30	.763
Spend time and resources to learn more about food safety in your facility	4.44	0.78	.679
Prevent food borne illness through proper implementation of GMPs and process controls.	4.85	.42	.414
Implement an environmental monitoring program in your facility.	4.44	1.03	.897

Note. Each item was paired with a five-point scale ranging from always (5) to never (1). Cronbach's alpha (α= .78) and PCA results (all items over 0.4 factor loadings) indicated acceptable reliability and validity, respectively. n=41

Table 8

Item Mean, Standard Deviation and Factor Loadings for the Self-efficacy in Demonstrating Food Safety Skills.

Item Questions	Mean	SD	Factor Loadings
Identify if the cheese you make is high risk or not	6.29	0.75	.691
Find laws and regulations required for manufacturing cheese in my facility	6.22	0.76	.856
Identify the factors which will affect the growth of bacteria in cheese	6.32	0.72	.500
Locate the areas that are high risk for pathogens	6.29	0.90	.774
Implement GMPs (good manufacturing practices) and process controls	6.41	0.77	.769
Implement a program for monitoring for pathogens in the environment	6.37	0.73	.950

Note. Each item was paired with a seven-point scale ranging from extremely certain I could not (1) to extremely certain I could (7) Cronbach's alpha (α= .96) and PCA results (all items over 0.5 factor loadings) indicated acceptable reliability and validity, respectively. n=41

There was no significant difference ($p < 0.05$) in the mean of experiential attitude and instrumental attitude scores was observed, although the mean score for the instrumental attitude scores of the sample participants is higher compared to the experiential attitude on a 7-point

scale for 41 participants. When participants were asked if learning about food safety practices would help them create a safer product, 93% said that it was extremely likely. This shows that the participants strongly believe that the knowledge about food safety is important in producing safe food for their customer. Learners also seemed confident that applying good manufacturing practices, process controls, and environmental monitoring would minimize food safety risk hazards in their facility. Participants' intention to adopt proper cleaning and sanitation protocols to prevent cross-contamination were the highest; whereas, the intention to spend time and resources to learn more about food safety was the lowest (Table 7).

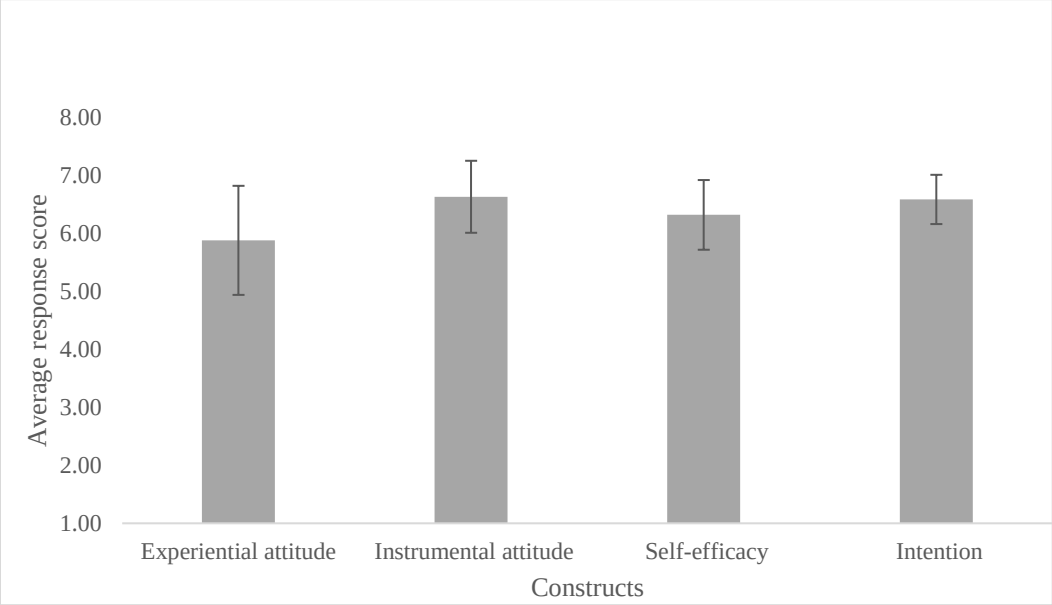

Figure 2. The average score of participants in each category for experiential attitude (Extremely displeasing (1) to Extremely pleasing (7)), instrumental attitude (Extremely unlikely (1) to Extremely likely (7)), self-efficacy (Extremely certain I could not (1) to Extremely certain I could (7)) and Intention (Always (5) to Never (1)). Self-efficacy scores and intention scores were standardized to 7-point scale.
n=41

A multiple regression model was conducted to predict intention of the participants to follow food safety protocols in their cheesemaking facility from self-efficacy scores, instrumental attitude scores, and experiential attitude scores. A regression model explained approximately 51% of the variance of the intended food safety behavior where $R^2 = 0.55$. This

was significantly different at F (3, 40) = 15.034, $MS_{residual}$ = 0.172, $p < 0.001$ (Table 9). However, only one predictor (i.e. Instrumental attitude) contributed significantly to the prediction of intention to follow food safety protocols (Table 9). Participants' intention to follow food safety principles was not significantly predicted by experiential attitude, self-efficacy, and knowledge gains in this study. An experimental regression model that included age, years of experiences, and gender of the participants was used to determine if any of these factors could predict intended behavior, but none did. In this study, the instrumental attitude was the strongest predictor of the behavioral intention to follow food safety protocols, which contradicts the results of the previous study in which experiential attitude or affective attitude, as opposed to instrumental attitude, was a significant predictor of intended behavior to perform physical activities (Rhodes, Fiala, & Conner, 2009). Other studies done on food safety domain where there were significant changes in attitude of the food handlers post training intervention were assessed (Thimoteo da Cunha, et al., 2014; Dudeja et al., 2017) Though there is self-perceived knowledge gain from the training intervention, this knowledge gain could not predict intentions toward food safety in the regression model. This result is similar to other studies (Ajzen, 2011) that show knowledge gain is a weak predictor of behavioral intentions to bring desired changes and that knowledge is an essential but not as sufficient condition. Increased knowledge from food safety training may not translate into improved attitudes and practices of food safety (Roberts, 2008).

Table 9.

Linear Regression Predicting Intentions to Perform Food Safety Behaviors

Variable	B	*SE B*	β	*t*	p
Self-efficacy	-.010	.119	-.010	-.085	.933
Exp. Attitude	.128	.082	.202	1.56	.127
Inst. Attitude	.593	.131	.619	4.53	.001
R^2 = .549					
F=15.034,					
p<.001					

Note: n=41

In this study, only the post training attitude was measured as compared to the other previous studies done on food safety where an assessment of change in attitude of food handlers after intervention were reported (Lillquist et al.,2005; Fenton et al., 2006; Thimoteo da Cunha, et al.,2014; Dudeja et al., 2017). According to Dudeja et al. (2017) participants' attitude toward food safety changed significantly post training. The baseline attitude of food handlers was neutral to aspects like their role in food safety, receiving any training and its impact on food safety, wearing of protective clothing at the work place, etc.

Practice Change

Twenty-one participants took this survey, but only 16 responses were included who were either a cheesemaker and/or the owner of a cheesemaking facility. Participant responses are shown in Table 10-11. Thirty-eight percent of respondents said that they have updated their pest control program after taking the course, and some participants reported to have sealed the cracks and holes in their facility to prevent pests from entering. However, 62% of respondents said that they do not intend to make changes because they are already compliant. Similarly, for exterior grounds, 13% of participants reported that they "Cut down weeds next to the barn and took measures to control weeds". Eighty-seven percent said no changes were made either because

they were compliant or because they cannot make any changes to the exterior because they lease their facility. For the construction and design of the facility, 87% said they did not change anything after the training course because either they are already compliant, or they intend to bring some changes like flow of material and air inside the facility and plan to do zoning. In personal health and hygiene, 33% of participants said that they had brought changes to their facility, while 67% said they had not. Most of the participants (73%) did not change their sanitation program because they consider themselves fully compliant with the rules and best practices. Ninety-three percent reported that their equipment design and maintenance are good and do not require any changes. For cleaning and sanitizing, in process testing, and environmental monitoring, participants reported that they wanted to update their programs based on the training. On the contrary, more than 65 % of participants said that they do not intend to change anything currently as they feel they are following the regulations and requirements.

Table 10

Percentage of Behavior Change

GMP practices	Yes	No	No but intent to
Pest Control	37.50%(6/16)	50.00%(8/16)	12.50%(2/16)
Exterior grounds	12.50%(2/16)	75.00%(10/16)	12.50%(2/16)
Construction or design of facility	13.30%(2/15)	66.70(10/15)	20.00%(3/15)
Personnel health and hygiene	33.00%(5/15)	47.00%(7/15	20.00%(3/15)
Sanitary facilities and controls	26.67%(4/15)	66.67%(10/15)	6.67%(1/15)
Equipment design, installation and maintenance	6.67%(1/15)	86.67%(13/15)	6.67%(1/15)
Material management	33.30%(5/15)	33.30%(5/15)	33.30%(5/15)
Cleaning and sanitizing	33.30%(5/15)	46.67%(7/15)	20.00%(3/15)
Testing	26.67%(4/15)	40.00%(6/15)	33.33%(5/15)
Environmental monitoring	0.00%(0/15)	66.67%(10/15)	33.33%(5/15)

Note: n=16

Data obtained from the self-reported practice change survey provided a positive representation of participants' food safety knowledge and adherence to food safety practices as most participants reported that they do not intend to change food safety related practices because they are already in compliance in their facility. However, due to lack of observational data, participant compliance with the requirements could not be confirmed. Other studies done on food safety suggest that a clear discrepancy exists between observational and self-reported data regarding food safety practices (Clayton et al., 2002, DeDonder et al., 2009)

Table 11

Participants' Response to Survey 3 -Practice Changes After the Training Intervention

Practice change category	Yes/No (frequency)	Reasons of changes brought in or changes not brought in
Pest Control	Yes – 6 (38%)	Sealing of cracks in floor, ceiling, walls and front door (1) Training the employees about pest control (3) Maintaining a documented log of pest control (1) Hired a pest control company who can monitor pests monthly (2)
	No – 10 (62%)	Written a pest control program (1) Already compliant (6) Small home producer so no changes necessary (3)
Exterior grounds	Yes-2 (13%)	Cut down weeds next to the barn (1) Exterior of the building trimmed and treated to control weeds (1)
	No- 14(87%)	Already compliant (11) No control over exterior of the building as it is a leased facility Have plans to review maintenance program to prevent cross contamination
Construction and design of the facility	Yes- 2 (12.5%)	Fitted new air condition to aid ventilation (2) Cleared clutters (1) Changed the zones arrangement to keep raw materials away from finished products (2) Changed the drain brushes as suggested in the course (1)
	No- 14(86.5%)	Already compliant (12) Plan to review air flow and material flow in the facility (1) Building a new facility and keeping the suggestions given in the training (1)
Personnel health and hygiene	Yes- 5(33%)	Follow more rigorous hygiene (3) More aware of personal health and hygiene practices (2) Started giving employee training and issuing appropriate clothing, protective equipment and footwear (1)

Table 11 (continued)

Sanitary facilities and control	No- 10(67%)	Already compliant- employees maintain log of their personal daily health (6) Plan to install a foot washing station Plan to update employee training based on the course and document (3)
	Yes- 4(27%)	Implemented food safety zone awareness and improved sanitation suggested in the course. (1) Updated sanitary log of the facility (2) Trash is removed everyday (1)
Equipment Design, installation and maintenance	No 12(73%)	Already compliant (11)
	Yes- 1(7%)	Plans to put water purification system in the facility (1)
	No- 15(93%)	Already complaint in terms of having proper design, stainless steel and food grade plastic (14) Can't afford to have new equipment's due to very small size of the business (1)
Material Management	Yes-5 (33%)	Raw material program updated (1) Increased monitoring of raw material (2)
	No- 10(67%)	
Cleaning and sanitizing	Yes-5(33%)	Increased awareness Communicating the new knowledge about cleaning and sanitizing products in the facility (2) Seeking out suitable cleaner for drainage system (1)
	No-10(67%)	Already compliant (5) Plan to use environmental friendly compounds Panning to change sanitizers Planning to rewrite sanitation program based on the course
In-process testing	Yes-4 (27%)	Testing and monitoring pH (2) More thorough testing for listeria (1) Tested milk samples in state lab for verification and microbial count (1)
	No-11(73%)	Already compliant (11) More training is required to establishing own labs for testing Plan to do index organism testing.
Environmental monitoring	Yes-0	N/A
	No- 15(100%)	Already compliant (10) Plans to do in near future (2) ATP meter is too expensive for small cheesemakers (1) Plans to update current environmental monitoring program (2)

Note. n=16

Though this online food safety training was effective in positively influencing artisan cheesemakers across the U.S. to increase their knowledge about cheese safety, it did not bring practice changes for most of the learners. Fifty-eight percent of participants reported that they do not intend to change their food safety practices because they are already in compliance. This result is similar to another study (Rowell et al., 2013) in which increase in knowledge had little impact on practice changes of food handlers.

This online training should be integrated with face-to-face training or workshops from phase 2 and phase 3 (as proposed in chapter 1) to give the cheesemakers more hands-on practice and confidence to carry out food safety behavior in their facility such as implementation of GMPs and environmental monitoring. Apart from this, regular refresher training should be encouraged among cheesemakers (Cohen, et al., 2001). Cohen et al. also suggested that practice change or behavior change can be encouraged if, along with effective training, there are adequate resources and appropriate encouragement from management.

LIMITATIONS

One limitation of this study was that the relatively small sample size of 41 participants who responded to survey “2” was relatively small compared to the population of approximately 1,000 artisan cheesemakers across the U.S., and, therefore, the interpretation of these findings should be treated as a pilot study. Future research needs to include a larger sample size and use a randomized sampling process to generalize findings. Also, the participants of this training chose to voluntarily complete this course unless if someone told them to do it which is not known. Therefore, the findings of this study may be skewed towards those cheesemakers who are more educated and, or have good networking etc.

Additional potential bias was that both analysis and the program evaluation were being conducted by the same person. This bias could have been overcome by having a third party do the program evaluation (Fitzpatrick, et al., 2011)

Finally, the study results were based on self-reported data collected through an online survey. A collection of observation research data may be considered for future research work, which can validate the compliance of self-reported food safety practices.

CONCLUSION

This study analyzed the effectiveness of an online food safety training program for artisan cheesemakers in terms of learners' satisfaction, knowledge gain, attitude, self-efficacy, and intended behavior toward food safety. Results show that 97% of participants were satisfied with the training and felt the content was very relevant to their needs. Participants also said that the training was interactive and engaging and that they could complete it at their own pace. There is knowledge gain for all five lessons with high mean scores for attitude, self-efficacy, and intention to implement food safety in cheesemaking facilities though not statistically significant. The mean score for the instrumental attitude scores of the sample participants is higher compared to the experiential attitude. Despite having high scores in attitude, self-efficacy, and intention, the regression model showed that intended food safety behavior of the cheesemakers is only predicted by instrumental attitude and is responsible for 51% variance. Post training, self-reported data shows an average of 22% of participants have changed or updated their food safety practices and/or programs related to GMPs in their facility, 58% do not intend to change anything, and 20% intend to change soon.

Finally, future studies are required where a training program on food safety and sanitation can be evaluated more effectively if there are observed data on practice changes along with self-reported data by the participants.

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APPENDICES

Appendix A: Needs Assessment Survey

Artisan cheese food safety training program

Default Question Block

Survey to determine the learning objectives of a food safety training program for artisan/farmstead cheese-makers.

Informed Consent Form

Purpose of Study-The goal of this study is to conduct a needs assessment and determine the competencies for an online basic food safety training program for artisan cheese-makers.

Procedures- You will be asked a set of questions about your knowledge of artisan cheese-makers in your area. This survey consists of 7 questions and will take approximately 15 minutes. The questions are intended to determine the course design for artisan cheese-makers for safe handling of food. This questionnaire will be conducted using an online Qualtrics-created survey. The results of this survey will be used to develop an online course material on food safety for artisan cheese makers.

Risks/Discomforts- Risks are minimal for involvement in this study. All questions are straightforward. You may decline to answer any question without stating a reason and without penalty.

Benefits-There are no direct benefits for participants. However, it is hoped that through your participation, researchers will be able to educate and equipped artisan cheese makers to sustain in this competitive food market by promoting food safety.

Confidentiality- All data obtained from participants will be kept confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). All questionnaires will be concealed, and no one other than the primary investigator and assistant researchers listed below will have access to them. The data collected will be stored in the HIPPA-compliant, Qualtrics-secure database until it has been deleted by the primary investigators.

Participation- Participation in this research study is completely voluntary. You have the right to withdraw at anytime or refuse to participate or answer any question entirely without penalty.

Questions about the Research- If you have questions regarding this study, you may contact principal investigator, Dr. Clint Stevenson (919-513-2065, clint_stevenson@ncsu.edu) or research assistant, Madhu Dutta (mdutta2@ncsu.edu).

Questions about your Rights as Research Participant- If you have questions you do not feel comfortable asking the researcher, you may contact the director of NC State University's Institutional Review Board, Debra Paxton, at 919-515-4514 or debra_paxton@ncsu.edu.

Thank you for your time!

I have read and understood the above informed consent form, and I consent to participate in this study.

- Yes
- No

	How IMPORTANT are the following competencies for artisan-cheese makers?				
	Not at all Important	Slightly Important	Neutral	Moderately Important	Very Important
Explaining the importance of food safety					
Identifying and interpreting food safety regulations					
Identifying various physical hazards					
Identifying various chemical hazards					
Identifying the various biological hazards					
Conducting a hazard analysis					
Assessing examples of Good Manufacturing Practice					
Allergen preventive controls					
Sanitation preventive controls					
Supply chain preventive controls					

	How IMPORTANT are the following competencies for artisan-cheese makers?				
	Not at all Important	Slightly Important	Neutral	Moderately Important	Very Important
Process-related preventive controls (e.g. curd cooking, water activity, acidification, etc.)	○	○	○	○	○
Environmental monitoring	○	○	○	○	○
Outlining the basic components of a food safety plan	○	○	○	○	○
Developing a food safety plan	○	○	○	○	○
Implementing a food safety plan	○	○	○	○	○
Developing a food recall plan	○	○	○	○	○
Implementing a food recall plan	○	○	○	○	○
Food safety training program for employees	○	○	○	○	○
Identifying informational food safety resources (e.g. regulations, Bad Bug Book, guidelines, etc.)	○	○	○	○	○

	How COMPETENT are artisan cheese-makers with the following?				
	Not at all competent	Slightly competent	Average	Moderately competent	Very Competent
Explaining the importance of food safety	○	○	○	○	○
Identifying and interpreting food safety regulations	○	○	○	○	○
Identifying various physical hazards	○	○	○	○	○
Identifying various chemical hazards	○	○	○	○	○
Identifying various biological hazards	○	○	○	○	○
Conducting a hazard analysis	○	○	○	○	○
Assessing examples of Good Manufacturing Practice	○	○	○	○	○
Allergen preventive controls	○	○	○	○	○
Sanitation preventive controls	○	○	○	○	○
Supply chain preventive controls	○	○	○	○	○

	How COMPETENT are artisan cheese-makers with the following?				
	Not at all competent	Slightly competent	Average	Moderately competent	Very Competent
Process-related preventive controls (e.g. curd cooking, water activity, acidification, etc.)	○	○	○	○	○
Environmental monitoring	○	○	○	○	○
Outlining the basic components of a food safety plan	○	○	○	○	○
Developing a food safety plan	○	○	○	○	○
Implementing a food safety plan	○	○	○	○	○
Developing a food recall plan	○	○	○	○	○
Implementing a food recall plan	○	○	○	○	○
Food safety training program for employees	○	○	○	○	○
Identifying informational food safety resources (e.g. regulations, Bad Bug Book, guidelines, etc.)	○	○	○	○	○

How likely are the following artisan cheese-making operations to have a food safety plan in place?

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Very small sized operation (less than 5 workers)	○	○	○	○	○	○	○
Small sized operation (5-15 workers)	○	○	○	○	○	○	○
Medium sized operation (16-50 workers)	○	○	○	○	○	○	○
Large sized operation (greater than 50 workers)	○	○	○	○	○	○	○

On average, how likely are artisan cheese-makers to have access to the following technologies?

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Smart phone	○	○	○	○	○	○	○
Computer	○	○	○	○	○	○	○
Tablet	○	○	○	○	○	○	○
Internet	○	○	○	○	○	○	○

Please select the state and county in which you currently reside.

State: ▼
County: ▼

How often are food safety training opportunities offered to artisan cheese-makers in your region?

- ○ More than 6 times a year
- ○ 4-6 times a year
- ○ 2-3 times a year
- ○ Once a year
- ○ Never

Appendix B: Names of SMEs Contacted Via Email

Names of SMEs contacted

1. Dr. Denis D'Amico
2. Dr. Martin Weidmann
3. Dr. Rob Machado

Some emails conversation with SMEs:

Martin Wiedmann <martin.wiedmann@cornell.edu> 2/21/16

to me

See below in red

From: Madhumeeta Dutta [mailto:mdutta2@ncsu.edu]
Sent: Wednesday, February 17, 2016 8:27 AM
To: Martin Wiedmann <martin.wiedmann@cornell.edu>
Subject: Re: Artisan cheese needs assessment survey-feedback

Hello Dr. Wiedmann,

Hope this email finds you well. It was nice talking to you when you visited NC State.
For my artisan cheese project I 'm doing learners analysis. Since you have worked very closely with the target audiences I will be lucky if you could share some of your experiences with me. I would like to know few thing about these artisan cheese maker:
1. Demographics- Ethnic and racial diversity of artisan cheese makers, where are they located, who are they mostly.
Vast majority white; >50% female
2. Intelligent and mental capabilities of the target audience- level of intelligence and cognitive ability, level of structured instructional environment.
Most will have a BS degree
3. Prior knowledge of food safety
Typically non or very limited; on-job knowledge or knowledge equivalent to a serve safe course
4. Motivation, attitudes and goals of artisan cheese makers in general.
Most of them want to either (i) make better, non-industrial food or (ii) hate the low price they get for selling milk and hence get into cheese making

Nice talking to you, and thanks for the interest in my project.
Attached I got pretty much everything that I used to collect data and a low resolution version of the training we developed.

I modified a handwashing evaluation tool I found in the literature, you'll see that it creates a score. All my participants accepted me recording with my smartphone they washing their hands. It made it a lot easier to analyse and give an score later. But, if your student train it, it is doable on the fly.

The "Tests.zip" has all my tests for the educational portion. The only difference between pre and post-test was that I did not include the demographics part in the post-testing.

The Cheesemaker and Inspector surveys are what I used for the needs assessment. The "Smart check list" have things that I observed during my visits for the needs assessment as well. I also took mental notes of "weird" stuff I saw and will add it in a less structured way in my dissertation.

The training is a low-res PDF, so please don't use it for professional printings. If you plan on really using it, I have the original editable files, and after using it, there are some little errors that passed our reviews and some minor things I would change. We can discuss that further if needed.

Please give my contact info to your student. This is my LinkedIn profile (linkedin.com/in/rammachado) and my phone number is 814 321-1683.

I look forward to see this project idea "spread" around. Please keep me on the loop.

Best,

Rob

Robson A. M. Machado
PhD Candidate
Department of Food Science
The Pennsylvania State University
202 Rodney A. Erickson Food Science Building
University Park, PA 16802
Email: ram471@psu.edu
PennState

Madhumeeta Dutta <mdutta2@ncsu.edu> 2/3/16
to Dennis

Hi Dr. D'Amico,

Thank you for your feedback. Your feedback is valuable and I am working on it. I will be sending out the survey very soon.
In regard to your first feedback about the scale of the cheese industry, do you have specifications of a small, medium and large artisan cheese industry in US on whose basic we can define them? I tried to do some research on this but could not find a proper specification for them.

Thank you,

D'Amico, Dennis <ddamico@uconn.edu> 2/19/16
to me

HI Madhu,

I wish I could help more but this is a very diverse population. Since our survey of the population is not complete (it is in the development stage) we do not have any quality data on demographics, educational experience, etc. The only insight I can provide is based on general observations of a few so it is not applicable across the industry and may not be accurate.

Let me know if there is another way I can help.

Have a nice weekend,
Dennis

Madhu,

Here is a link to my dissertation https://drive.google.com/open?id=0B527c-vIHItoUlhKdWxVWGpHM00

I don't know of a source that have information about distribution in the entire US. You could check the Atlas of American Artisan Cheese, but I know that it is not comprehensive (https://www.amazon.com/American-Artisan-Cheese-Jeffrey-Roberts-ebook/dp/B0063J26KO/ref=dp_kinw_strp_1#nav-subnav).

Please use this email for future communications.

Best,
Rob

Dr. Robson Machado
Assistant Extension Professor and Food Safety Specialist
University of Maine Cooperative Extension
robson.machado@maine.edu

Mailing address
5735 Hitchner Hall
University of Maine
Orono, Maine 04469

Madhu,

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University of Maine Cooperative Extension
robson.machado@maine.edu

Mailing address
5735 Hitchner Hall
University of Maine
Orono, Maine 04469

From: Robson Machado <ram471@psu.edu>
Date: December 7, 2015 at 12:41:19 PM EST

Subject: Re: Let's not reinvent the wheel! Hooray for academic collaboration!

Hi Madhu,

I think that extrapolation the data I found here in PA to the rest of the country is very hard. Especially because of the Amish population (about half of my participants are Amish). If we see this map (http://digitalunion.osu.edu/r2/summer07/eellis/) (not sure how accurate this is, it is not a scientific source, I just did a quick check on the internet), we can see that the Amish population is more present on the East + North portion of the state. On top of that, my sample is small (16 farms) and it was a convenience sample. All this characteristics impose problems for extrapolation that would be hard to defend. I believe you guys would have to collect data from your state (that seems not to have that many Amish) and compare to PA. If there is no difference, you could argue that at least the East portion of the country, probably, have similar characteristics. You would also have to show that the dairy farms' "profile" of the two states (number of dairy farms, their sizes, family-oriented farms or not, etc.,) are similar. Again, if you look at this map (http://www.factoryfarmmap.org/#animal:dairy;location:US;year:2012) you'll see that for dairy farms, the distribution of "factory" dairy farms are very different across the country.

Best,

Rob

Robson A. M. Machado
PhD Candidate
Department of Food Science
The Pennsylvania State University

Appendix C: Summary of Cheesemaker's Interview

Cheese facilities in North Carolina	**Years of business**	**Type of milk used for cheesemaking**	**Follow food safety plan (Y/N)**	**Challenges**	**Numbers of employees**
Goat Lady Dairy- Steve Tate	15 years	Pasteurized Cow and Goat milk	Yes HACCP	Difficulty in understanding the requirements of FSMA	11-15
Boxcarr Dairy- Samantha Genke	3 years	Pasteurized Cow and Goat milk	Partially Document their process	No profit, Difficulty in getting right information on law and regulations;	4-7
Piemonte Farm- Fabian and Sandra Sarlinga	5 years	Raw as well as Pasteurized Cow, Sheep and Goat milk	Partially	Trouble finding right information and resources	3
Elodie Farms- Ted Domville	1.5 years	Pasteurized Goat milk	NO	Slim profit margins; trouble finding resources; Wants to learn more about environmental	4

				pathogen monitoring.	
Prodigal Farm- Kathryn Spann and Dave	3 years	Pasteurized Goat milk	NO	Slim profit margins	4

Semi structured questions asked to the owners of the artisan cheese facilities:

1. How long they have been making cheese?
2. What are challenges in general artisan cheesemakers of the community are facing?
3. How equipped are the local cheese producers to deal with the food safety regulations which are coming up?
4. How many people are working in the facility and what they do?
5. Do they follow any food safety plans in their facility?
6. What kind of milk they use for cheese making pasteurized or raw milk?

Appendix D: Artisan Cheese Recalls in Recent Years

Outbreak Title	Year	Link
Meijer Brand Colby and Colby Jack Deli Cheese	2017	http://www.fda.gov/Safety/Recalls/ucm541224.htm
Sargento - specialty Longhorn Colby cheese	2017	http://www.fda.gov/Safety/Recalls/ucm541527.htm
Guggisberg Cheese, Inc. recalls various Colby Type Cheeses	2017	http://www.fda.gov/Safety/Recalls/ucm541732.htm
Saputo - Gouda	2017	http://www.fda.gov/Safety/Recalls/ucm542225.htm
Biery Cheese Company, various types of specialty Longhorn Colby Cheeses	2017	http://www.fda.gov/Safety/Recalls/ucm542271.htm
MDS Foods, Inc., Massillon, OH expanding current recall to include products Id'd by Deutsch Kase Haus, LLC of Middlebury, Indiana	2017	https://www.fda.gov/Safety/Recalls/ucm542407.htm
Meijer Artisan Made Natural Muenster Cheese and its prewrapped Ham Sub on Artsan White Baguette	2017	https://www.fda.gov/Safety/Recalls/ucm544915.htm
Vulto Creamery - All soft, wash-rind raw milk cheeses	2017	https://www.fda.gov/Safety/Recalls/ucm545289.htm
Whole Foods, 9 stores	2017	https://www.fda.gov/Safety/Recalls/ucm545716.htm
Biery Cheese Company, various types of specialty	2017	https://www.fda.gov/Safety/Recalls/ucm545684.htm

Longhorn Colby Cheeses		
La Nica Products, Miami, FL	2017	https://www.fda.gov/Safety/Recalls/ucm558908.htm
Henning's Cheese, Colby Jack	2017	https://www.fda.gov/Safety/Recalls/ucm559223.htm
Global Garlic INc, Queso Fresco	2017	https://www.fda.gov/Safety/Recalls/ucm559225.htm
Queso Fresco	2017	https://www.fda.gov/Safety/Recalls/ucm561927.htm
Maytag Dairy Farms Expands Voluntary Recall of Blue Cheese Due to Food Safety Concern	2016	http://www.fda.gov/Safety/Recalls/ucm486976.htm
Grassfields Cheese Recall Affects Select Whole Foods Market Locations; Grocer Recalls Product from Cheese Departments	2016	http://www.fda.gov/Safety/Recalls/ucm514967.htm
Chapel Hill Creamery Recalls Cheese Products Because of Possible Health Risk	2016	http://www.fda.gov/Safety/Recalls/ucm513946.htm
Forever Cheese Recalls Imported Mitica Brand Pecorino Aged Cheese in Walnut Leaves for Possible Health Risk	2016	http://www.fda.gov/Safety/Recalls/ucm486414.htm
DATCP Issues Consumer Advisory for Cottage Cheese Produced by Westby Cooperative Creamery (Wisconsin	2016	http://www.fda.gov/Safety/Recalls/ucm519371.htm

Dept of Ag, Trade and Consumer Protection, Aug 2, 2016)		
Apple Tree Goat Dairy, PA	2016	http://www.fda.gov/Safety/Recalls/ucm521592.htm
Whole Foods Recalls Maytag Blue Cheese Due to Listeria Risk	2016	http://www.huffingtonpost.com/entry/blue-cheese-recall-whole-foods-maytag_us_56d6ebc1e4b0bf0dab33ed09
Market of Choice is recalling its Market Cheese Shop Baked Brie Herb/Garlic variety, due to undeclared pecans.	2015	http://www.fda.gov/Safety/Recalls/ArchiveRecalls/2015/ucm467033.htm
Whole Foods Market Voluntarily Recalls All Cut, Wrapped and Weighed Papillon Organic Roquefort Cheeses Because Of Possible Health Risk	2015	http://www.fda.gov/Safety/Recalls/ArchiveRecalls/2015/ucm466185.htm
Karoun Dairies Cheese Linked to 9 State, 24 Person and 1 Death Listeria Outbreak	2015	http://www.foodpoisonjournal.com/foodborne-illness-outbreaks/karoun-dairies-cheese-linked-to-9-state-24-person-and-1-death-outbreak/#.Vvx-fIwrJn0
Staphylococcus in Queso Fresco Cheese	2015	http://www.fda.gov/Safety/Recalls/ArchiveRecalls/2015/ucm443851.htm
Oasis Brands Inc. Recalling Select lots of Lacteos Santa Martha Products Possibly Contaminated with Listeria	2014	http://www.foodsafetynews.com/2014/10/dairy-products-recalled-for-possible-listeria-contamination/#.V6UT8VdOJ0c

Parkers Farm Recalls Cheese and Salsa Products for Potential Listeria	2014	http://www.foodsafetynews.com/2014/06/draft-parkers-farm-recalls-cheese-and-salsa-products-for-potential-listeria/#.V6UUkFdOJ0c
French Cheese Sold in US Recalled for Salmonella Contamination	2014	http://www.foodsafetynews.com/2014/05/french-cheese-recalled-for-salmonella-contamination/#.V6UUuldOJ0c
The Cultured Kitchen® Voluntarily Recalls Cashew Cheese Due to Possible Risk of Contamination from Salmonella	2014	http://www.fda.gov/Safety/Recalls/ucm380115.htm
Raw Goat Milk Cheese Recalled in WI for E. coli O111	2014	https://foodpoisoningbulletin.com/2014/raw-goat-milk-cheese-recalled-in-wi-for-e-coli-o111/
Le Verdict d'Alexina and Grey Owl cheese recalled due to a toxin produced by Staphylococcus bacteria	2014	http://www.inspection.gc.ca/about-the-cfia/newsroom/food-recall-warnings/complete-listing/2014-06-27c/eng/1403922586498/1403922594227
Roos Foods Recall - 8 Sickened, 1 Dead because of *L. monocytogenes*	2014	http://www.foodsafetynews.com/2014/02/cheese-sickens-8-in-md-and-ca-with-listeria-one-dead/#.V6UU_FdOJ0c
Jindi Cheese Company - Soft Cheese Listeria Outbreak Spreads	2013	http://www.foodqualitynews.com/Food-Outbreaks/Australian-cheese-listeria-outbreak-linked-to-two-deaths
Crave Brothers Cheese Sickens 6 in 4 States	2013	http://www.foodpoisonjournal.com/foodborne-illness-outbreaks/listeria-outbreak-and-recall-crave-brothers-cheese-sickens-6-in-4-states-1-dead-1-miscarriage/#.V6UN3FdOJ0c
Twenty-five Salmonella illnesses now linked to	2013	http://www.health.state.mn.us/news/pressrel/2013/salmonella052013.html

homemade unpasteurized fresh cheese		
Finger Lakes Farmstead Cheese Company LLC Recalls Gouda Cheeses Because of Possible Health Risk	2013	http://www.fda.gov/Safety/Recalls/ucm355047.htm
Whole Foods recalls French Cheese because it may be contaminated with *L. monocytogenes*	2013	http://www.foodsafetynews.com/2013/08/listeria-risk-prompts-cheese-recall/#.V6UVyFdOJ0c
Staphylococcus Aureus in Quesito Colombiano, Colombian Style Cheese	2012	http://www.fda.gov/Safety/Recalls/ucm313578.htm?source=govdelivery
Morningland Dairy - Rawesome Foods Raid	2012	http://www.foodsafetynews.com/2012/07/rawesome-foods-founder-arrested/#.V6UDLFdOJ0c
Multistate Outbreak of Listeriosis Linked to Imported Frescolina Marte Brand Ricotta Salata Cheese	2012	http://www.cdc.gov/listeria/outbreaks/cheese-09-12/
Staphylococcus Aureus in Queso Fresco Cheese	2011	http://www.fda.gov/Safety/Recalls/ucm259411.htm
Estrella Family Creamery Banned from interstate commerce after repeated findings of *L. monocytogenes*	2010	http://www.foodsafetynews.com/2012/11/estrella-family-creamery-cheese-sales-restricted/#.V6UF2ldOJ0c
Multistate Outbreak of E. coli O157:H7 Infections	2010	http://www.cdc.gov/ecoli/2010/bravo-farms-cheese-11-24-10.html

Associated with Cheese		
Sally Jackson Cheese Confirmed as Outbreak Source	2010	http://www.foodsafetynews.com/2010/12/sally-jackson-cheese-confirmed-as-outbreak-source/#.VwcciowrK-U
Azteca Linda Corp. Recalls Queso Fresco and Queso Hebra because of Possible Health Risk	2010	http://www.fda.gov/Safety/Recalls/ucm223977.htm
Outbreak of Multidrug-Resistant *Salmonella enterica* serotype Newport Infections Associated with Consumption of Unpasteurized Mexican-Style Aged Cheese	2007	http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5716a4.htm

Appendix E: Retrospective Pre-posttest Questionnaire

Knowledge: Lesson 1

Please circle the appropriate number to indicate your level of knowledge about the following topics **before** and **after** completing the program. Please use the following key for rating:

1. Very Low = Don't know anything about this topic.
2. Low = Know very little about this topic
3. Moderate = Know about this topic but there are more things to learn
4. High = Have good knowledge but there are things to learn
5. Very High = Know almost everything about this topic

How do you rate your knowledge about?	BEFORE THIS ONLINE TRAINING					AFTER THIS ONLINE TRAINING				
	Very Low	Low	Moderate	High	Very High	Very Low	Low	Moderate	High	Very High
Importance of food safety for artisan cheesemakers.	1	2	3	4	5	1	2	3	4	5
Why cheese is high risk product.	1	2	3	4	5	1	2	3	4	5
Whole genome sequencing and how it impacts your business	1	2	3	4	5	1	2	3	4	5

Knowledge: Lesson 2

Please circle the appropriate number to indicate your level of knowledge about the following topics **before** and **after** completing the program. Please use the following key for rating:

1. Very Low = Don't know anything about this topic.
2. Low = Know very little about this topic
3. Moderate = Know about this topic but there are more things to learn
4. High = Have good knowledge but there are things to learn
5. Very High = Know almost everything about this topic

How do you rate your knowledge about?	BEFORE THIS ONLINE TRAINING					AFTER THIS ONLINE TRAINING				
	Very Low	Low	Moderate	High	Very High	Very Low	Low	Moderate	High	Very High
Relevant information in the Code of Federal Regulations for cheesemakers in terms of food safety.	1	2	3	4	5	1	2	3	4	5
Standards such as the (PMO) Pasteurized Milk Ordinance and the Food Code.	1	2	3	4	5	1	2	3	4	5
Retail consortium and where to look for other resources.	1	2	3	4	5	1	2	3	4	5

Knowledge: Lesson3

Please circle the appropriate number to indicate your level of knowledge about the following topics **before** and **after** completing the program. Please use the following key for rating:

1. Very Low = Don't know anything about this topic.
2. Low = Know very little about this topic
3. Moderate = Know about this topic but there are more things to learn
4. High = Have good knowledge but there are things to learn
5. Very High = Know almost everything about this topic

How do you rate your knowledge about?	BEFORE THIS ONLINE TRAINING					AFTER THIS ONLINE TRAINING				
	Very Low	Low	Moderate	High	Very High	Very Low	Low	Moderate	High	Very High
Categories of food safety hazards and categorize any given hazard into one of them.	1	2	3	4	5	1	2	3	4	5
Chemical food safety hazards in a cheesemaking facility	1	2	3	4	5	1	2	3	4	5
Physical hazards in a cheese making facility.	1	2	3	4	5	1	2	3	4	5
Factors that affect bacterial growth.	1	2	3	4	5	1	2	3	4	5
Four high risk biological pathogens typical in a cheese facility.	1	2	3	4	5	1	2	3	4	5
Areas in a cheesemaking facility that are high risk for pathogenic cross contamination.	1	2	3	4	5	1	2	3	4	5

Knowledge: Lesson4

Please circle the appropriate number to indicate your level of knowledge about the following topics **before** and **after** completing the program. Please use the following key for rating:

1. Very Low = Don't know anything about this topic.
2. Low = Know very little about this topic
3. Moderate = Know about this topic but there are more things to learn
4. High = Have good knowledge but there are things to learn
5. Very High = Know almost everything about this topic

How do you rate your knowledge about?	BEFORE THIS ONLINE TRAINING					AFTER THIS ONLINE TRAINING				
	Very Low	Low	Moderate	High	Very High	Very Low	Low	Moderate	High	Very High
Construction and design of a cheesemaking facility.	1	2	3	4	5	1	2	3	4	5
Personnel health and hygiene.	1	2	3	4	5	1	2	3	4	5
Sanitary facility and control (plumbing, water usage, sewage, etc.).	1	2	3	4	5	1	2	3	4	5
Equipment and design.	1	2	3	4	5	1	2	3	4	5
Cleaning and sanitation.	1	2	3	4	5	1	2	3	4	5
Materials management (warehousing).	1	2	3	4	5	1	2	3	4	5
Training	1	2	3	4	5	1	2	3	4	5
Process controls (cooking, acidification, aging, etc.).	1	2	3	4	5	1	2	3	4	
5 Responsibilities of PCQI	1	2	3	4	5	1	2	3	4	5

Knowledge: Lesson5

Please circle the appropriate number to indicate your level of knowledge about the following topics **before** and **after** completing the program. Please use the following key for rating:

1. Very Low = Don't know anything about this topic.
2. Low = Know very little about this topic
3. Moderate = Know about this topic but there are more things to learn
4. High = Have good knowledge but there are things to learn
5. Very High = Know almost everything about this topic

How do you rate your knowledge about	BEFORE THIS ONLINE TRAINING					AFTER THIS ONLINE TRAINING				
	Very Low	**Low**	**Moderate**	**High**	**Very High**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
Environmental pathogen monitoring.	1	2	3	4	5	1	2	3	4	5
The importance of environmental pathogen monitoring.	1	2	3	4	5	1	2	3	4	5
Environmental pathogen sampling zones in your facility.	1	2	3	4	5	1	2	3	4	5
In-process testing.	1	2	3	4	5	1	2	3	4	5
Finished product testing.	1	2	3	4	5	1	2	3	4	5

Appendix F: Learners' Satisfaction Survey

Informed Consent

Informed Consent Form

Purpose of Study- The goal of this study is to evaluate the training course and determine its impact on the participants.

Procedures- You will be asked a set of questions on your attitude, intensions and aspiration about food safety after the completion of the online training. This survey consists of 12 questions and will take approximately 10 minutes. The questions are intended to evaluate the effectiveness of the course for artisan cheesemakers. This questionnaire will be conducted using an online Qualtrics-created survey. The results of this survey will be used to improve the online course material on food safety for artisan cheesemakers.

Risks/Discomforts- Risks are minimal for involvement in this study. All questions are straightforward. You may decline to answer any question without stating a reason and without penalty.

Benefits- There are no direct benefits for participants. However, it is hoped that through your participation, researchers will be able to improve this course and equipped artisan cheesemakers to sustain in this competitive food market by promoting food safety.

Confidentiality- All data obtained from participants will be kept confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). All questionnaires will be concealed, and no one other than the primary investigator and assistant researchers listed below will have access to them. The data collected will be stored in the HIPPA-compliant, Qualtrics-secure database until it has been deleted by the primary investigators.

Participation- Participation in this research study is completely voluntary. You have the right to withdraw at any time or refuse to participate or answer any question entirely without penalty. Questions about the Research- If you have questions regarding this study, you may contact principal investigator, Dr. Clint Stevenson (919-513-2065, clint_stevenson@ncsu.edu) or research assistant, Madhu Dutta (mdutta2@ncsu.edu).

Questions about your Rights as Research Participant- If you have questions you do not feel comfortable asking the researcher, you may contact the director of NC State University's Institutional Review Board, Debra Paxton, at 919-515-4514 or debra_paxton@ncsu.edu.

Thank you for your time!

Consent

I have read and understood the above informed consent form, and I consent to participate in this study.

- Yes
- No

Artisan cheese evaluation survey

This survey is currently LOCKED to prevent invalidation of collected responses! Please unlock your survey to make changes.

Learners' satisfaction

Q1 How satisfied are you with:

	Extremely satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Extremely dissatisfied
The relevance of information of the training to your needs	○	○	○	○	○
The overall quality of the training	○	○	○	○	○

Q2 What are the strengths of this program?

Q3 What are the weaknesses of this program?

Q4 Did this training course meet your expectations?

- Yes
- No

Q5 Would you recommend this online training to others?

- Yes
- No

Display This Question:
If Would you recommend this online training to others? No Is Selected

Q6 If not, why?

Q7 How could this training be improved?

Q8 Would you be interested in giving some more feedback related to the training course?

- Yes
- No

Q25

Please provide your name and e-mail address below.

Name

Email address

Q25

KASA questions

Experi_ Attitude

Click the appropriate scale against each statement

	Extremely pleasing	Moderately pleasing	Slightly pleasing	Neither pleasing nor displeasing	Slightly displeasing	Moderately displeasing	Extremely displeasing
Learning about food safety is							
Following food safety rules is							
Applying Good Manufacturing Practices in my facility is							
Applying Process Controls in my facility is							
Implementing a program that monitors for pathogens in my cheesemaking facility is							

nstru
Attitude

Click the appropriate scale against each statement

	Extremely likely	Moderately likely	Slightly likely	Neither likely nor unlikely	Slightly unlikely	Moderately unlikely	Extremely unlikely
Learning more about food safety will help me create a safer product							
Food safety regulations will keep my products safer from contamination							
Applying Good Manufacturing Practices in my facility minimizes food safety risk							
Applying Process controls minimizes food safety risk							
Implementing a program that monitors for pathogens in my cheese making facility will keep my products safer from contamination							

Self-
Efficacy

How confident are you in your ability to

	Extremely Certain I Could	Moderately Certain I Could	Slightly Certain I Could	I do not Know	Slightly Certain I Could Not	Moderately Certain I Could Not	Extremely Certain I Could Not
Identify if the cheese you make is high risk or not							
Find laws and regulations required for manufacturing cheese in my facility							
Identify the factors which will affect the growth of bacteria in cheese							
Locate the areas that are high risk for pathogenic *Listeria.monocytogenes, E. coli*, Salmonella and Staphylococcus							
Implement GMPs (Good Manufacturing Practices) and process controls in order to reduce food safety risk							
Implement a program for monitoring for pathogens in the environment							

Intention

To what extent do you intend to

	Always	Most of the time	About half the time	Sometimes	Never
Follow personnel hygiene practices (frequent hand washing, no jewelry, wear hairnets and gloves while working) in your facility.					
Adopt proper cleaning and sanitation protocols to prevent cross-contamination.					
Spend time and resources to learn more about food safety in your facility.					
Prevent food borne illness through proper implementation of GMPs and process controls.					
Implement an environmental monitoring program in your facility.					

Education

What is your Highest level of Education?

- Less than high school
- High school graduate (includes equivalency)
- Some college, no degree
- Associate's degree
- Bachelor's degree
- Master's degree
- Ph.D.

Gender

What is your gender?

- Male
- Female

Age

What is your age?

- Under 18
- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- 65 - 74
- 75 - 84
- 85 or older

Ownership

Are you the owner / co-owner of your cheese-making facility?

- Yes
- No

Duration

How long you have worked in the cheese business?

- More than 10 years
- 5-10 years
- 3-5 years
- 2-3 years
- 1-2 years
- 0-1 year

Production

What is your annual cheese production volume per year?

- 5000 lbs. or less
- 5,001-10,000 lbs.
- 10,001- 20,000 lbs.
- 20,001- 50,000 lbs.
- Over 50,001 lbs.

Region

Which region of the country do you live in?

- West
- Midwest
- South
- East
- North
- Northeast
- Others

Milk

What kind of milk do you use for cheese making?

- Pasteurized milk for all cheeses
- Raw milk for all cheeses
- Combination

Appendix G: Practice Change Survey

Behavior change survey

This survey is currently LOCKED to prevent invalidation of collected responses! Please unlock your survey to make changes.

Default Question Block

Informed Consent Form

Purpose of Study-The goal of this study is to see if the learners incorporated the learned principles, skills and knowledge into the cheese making facility after the completion of the training course and determine its impact on the participants.

Procedures- You will be asked a set of 2 questions on the impact of the training about food safety after the completion of the online course. This will take approximately 10 minutes. The questions are intended to evaluate the effectiveness of the course for artisan cheesemakers. This questionnaire will be conducted using an online Qualtrics-created survey. The results of this survey will be used to improve the online course material on food safety for artisan cheesemakers.

Risks/Discomforts- Risks are minimal for involvement in this study. All questions are straightforward. You may decline to answer any question without stating a reason and without penalty.

Benefits-There are no direct benefits for participants. However, it is hoped that through your participation, researchers will be able to improve this course and equipped artisan cheese makers to sustain in this competitive food market by promoting food safety.

Confidentiality- All data obtained from participants will be kept confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). All questionnaires will be concealed, and no one other than the primary investigator and assistant researchers listed below will have access to them. The data collected will be stored in the HIPPA-compliant, Qualtrics-secure database until it has been deleted by the primary investigators.
Participation- Participation in this research study is completely voluntary. You have the right to withdraw at any time or refuse to participate or answer any question entirely without penalty.

Questions about the Research- If you have questions regarding this study, you may contact principal investigator, Dr. Clint Stevenson (919-513-2065, clint_stevenson@ncsu.edu) or research assistant, Madhu Dutta (mdutta2@ncsu.edu).

Questions about your Rights as Research Participant- If you have questions you do not feel comfortable asking the researcher, you may contact the director of NC State University's Institutional Review Board, Debra Paxton, at 919-515-4514 or debra_paxton@ncsu.edu.

Thank you for your time!

I have read and understood the above informed consent form, and I consent to participate in this study.

- Yes
- No

Name

Email address

Q45

Please indicate your role in the artisan cheese industry? Check all that applies.

- I am a cheesemaker
- I am an owner/ manager of a cheese company
- I am a consultant/ trainer
- I am a regulator
- I am a student

Condition: I am a cheesemaker Is Selected. Skip To: What is your annual cheese production....

Condition: I am an owner/ manager of a... Is Selected. Skip To: What is your annual cheese production....

Condition: I am a cheesemaker Is Not Selected. Skip To: End of Survey.

Condition: I am an owner/ manager of a... Is Not Selected. Skip To: End of Survey.

Q46

What is your annual cheese production volume per year?

- 5,000 lbs. or less
- 5,001-10,000 lbs.
- 10,001-20,000 lbs.
- 20,001-50,000 lbs.
- Over 50,001 lbs.
- Not applicable to me

1. **Pest Control**: Since you completed the online course, have you changed any procedures related to controlling pests?

Yes | No, and I do not intend to | No, but I intend to

Display This Question:
If Pest Control: Since you completed the online course, have you changed any procedures related to c... Yes Is Selected

Explain what procedures or behaviors you have changed regarding pest control since completing the course and why.

Display This Question:
If Pest Control: Since you completed the online course, have you changed any procedures related to c... No, and I do not intend to Is Selected

Explain why you did not change any procedures or behaviors related to pest control after completing the course.

Display This Question:
If Pest Control: Since you completed the online course, have you changed any procedures related to c... No, but I intend to Is Selected

Explain what pest control behaviors or procedures you intend to change since you completed the training and why.

Page Break

2. **Exterior grounds:** Since you completed the online course, have you changed any practices related to the design or maintenance of the exterior grounds?

Yes | No, and I do not intend to | No, but I intend to

Display This Question:
If Exterior grounds: Since you completed the online course, have you changed any practices related t... Yes Is Selected

Explain what practices regarding exterior grounds you changed since completing the online course and why.

Display This Question:
If Exterior grounds: Since you completed the online course, have you changed any practices related t... No, and I do not intend to Is Selected

Explain why you did not change any design or maintenance practices regarding exterior grounds since completing the course.

Display This Question:
If Exterior grounds: Since you completed the online course, have you changed any practices related t... No, but I intend to Is Selected

Explain what practices you intend to change of exterior design plans you intend to implement since completing the course.

3. **Construction or design of facility:** Since completing the online course, have you made any changes in the construction or design of your cheesemaking facility (e.g. hygienic zoning, floors, floor drains, lighting, ventilation, etc.)?

Yes | No, and I do not intend to | No, but I intend to

Display This Question:
If Construction or design of facility: Since completing the online course, have you made any changes... Yes Is Selected

Explain what practices regarding construction or design or maintenance of your cheesemaking facility (e.g. hygienic zoning, floors, floor drains, lighting, ventilation, etc.) you changed since completing the Artisan Cheese course and why.

Display This Question:
If Construction or design of facility: Since completing the online course, have you made any changes... No, and I do not intend to Is Selected

Explain why you did not change any design or maintenance practices regarding hygienic zoning, floors, floor drains, lighting, ventilation, etc. since completing the course.

Display This Question:
If Construction or design of facility: Since completing the online course, have you made any changes... No, but I intend to Is Selected

Explain what you intend to change in the construction or design of your facility since completing the course.

4. **Personnel health and hygiene :** Since completing the artisan cheese course, have you made any changes regarding the policies or practices concerning personnel health and hygiene (e.g. hand washing, not showing up to work while ill, footwear, jewelry, hair net, etc.)?

Yes | No, and I do not intend to | No, but I intend to

Display This Question:
If Personnel health and hygiene : Since completing the artisan cheese course, have you made any chan... Yes Is Selected

Explain what procedures or behaviors you have changed regarding policies or practices concerning personnel health and hygiene since completing the course and why.

Display This Question:
If Personnel health and hygiene : Since completing the artisan cheese course, have you made any chan... No, and I do not intend to Is Selected

Explain why you did not change any procedures or behaviors related to policies or practices concerning personnel health and hygiene after completing the course.

Display This Question:
If Personnel health and hygiene : Since completing the artisan cheese course, have you made any chan... No, but I intend to Is Selected

Explain what policies or practices concerning personnel health and hygiene behaviors or procedures you intend to change since you completed the training, and why.

5. **Sanitary facilities and controls :** Since completing the artisan cheese course, have you made any changes regarding the policies or practices concerning sanitary facilities and controls to prevent cross contamination (e.g. water usage, plumbing, sewage and trash disposal, hand washing facilities etc.)?

Yes | No, and I do not intend to | No, but I intend to

Display This Question:
If Sanitary facilities and controls : Since completing the artisan cheese course, have you made any... Yes Is Selected

Explain what procedures or behaviors you have changed regarding sanitary facilities and controls since completing the course and why.

Display This Question:
If Sanitary facilities and controls : Since completing the artisan cheese course, have you made any... No, and I do not intend to Is Selected

Explain why you did not change any procedures or behaviors related to policies or practices concerning personnel sanitary facilities and controls after completing the course.

Display This Question:
If Sanitary facilities and controls : Since completing the artisan cheese course, have you made any... No, but I intend to Is Selected

Explain what policies or practices concerning sanitary facilities and controls you intend to change since you completed the training and why.

6. **Equipment design, installation and maintenance:** Since you completed the online course, have you changed any equipment in terms of material used, installation and maintenance, and surface finish of the equipment?

Yes | No, and I do not intend to | No, but I intend to

Display This Question:
If Equipment design, installation and maintenance: Since you completed the online course, have you c... Yes Is Selected

Explain what you have changed regarding equipment design, installation and maintenance since completing the course and why.

Display This Question:
If Equipment design, installation and maintenance: Since you completed the online course, have you c... No, and I do not intend to Is Selected

Explain why you did not change any equipment design, installation and maintenance after completing the course.

Display This Question:
If Equipment design, installation and maintenance: Since you completed the online course, have you c... No, but I intend to Is Selected

Explain which eqipment design or installation you intend to change since you completed the training and why.

7. **Material management :** Since completing the online course, have you made any changes regarding the policies or practices concerning material management in terms of receiving, storage, monitoring, documentation, etc.

Yes | No, and I do not intend to | No, but I intend to

Display This Question:
If Material management : Since completing the online course, have you made any changes regarding the... Yes Is Selected

Explain what procedures or behaviors you have changed regarding material management in terms of receiving, storage, monitoring, documentation, etc. since completing the course and why.

Display This Question:
If Material management : Since completing the online course, have you made any changes regarding the... No, and I do not intend to Is Selected

Explain why you did not change any procedures or behaviors related to material management in terms of receiving, storage, monitoring, documentation, etc. after completing the course.

Display This Question:
If Material management : Since completing the online course, have you made any changes regarding the... No, but I intend to Is Selected

Explain what policies or practices concerning material management in terms of receiving, storage, monitoring, documentation you intend to change since you completed the training and why.

8. **Cleaning and sanitizing:** Since completing the artisan cheese course, have you made any changes concerning cleaning and sanitizing policies or practices (e.g. types of cleaning and sanitizing compounds, documentation of sanitation program, storage of chemical compounds etc.)?

Yes | No, and I do not intend to | No, but I intend to

Display This Question:
If Cleaning and sanitizing: Since completing the artisan cheese course, have you made any changes co... Yes Is Selected

Explain what procedures or behaviors you have changed regarding cleaning and sanitizing programs since completing the course and why.

Display This Question:
If Cleaning and sanitizing: Since completing the artisan cheese course, have you made any changes co... No, and I do not intend to Is Selected

Explain why you did not change any procedures or behaviors related to cleaning and sanitizing programs after completing the course.

Display This Question:
If Cleaning and sanitizing: Since completing the artisan cheese course, have you made any changes co... No, but I intend to Is Selected

Explain which policies or practices concerning cleaning and sanitizing programs you intend to change since you completed the training and why.

9

Testing: Since you completed the online course, have you changed any procedures related to in-process testing or product testing?

Yes

No, and I do not intend to

No, but I intend to

Display This Question:

If Testing: Since you completed the online course, have you changed any procedures related to in-pro... Yes Is Selected

Explain what procedures or behaviors you have changed regarding in-process testing or product testing since completing the course and why.

Display This Question:

If Testing: Since you completed the online course, have you changed any procedures related to in-pro... No, and I do not intend to Is Selected

Explain why you did not change any procedures or behaviors related to in-process testing or product testing programs after completing the course

Display This Question:

If Testing: Since you completed the online course, have you changed any procedures related to in-pro... No, but I intend to Is Selected

Explain what in-process testing or product testing programs you intend to change since you completed the training, and why.

10

Environmental monitoring: Since you completed the artisan cheese course, have you changed any procedures related to environmental monitoring?

Yes | No, and I do not intend to | No, but I intend to

Display This Question:

If Environmental monitoring: Since you completed the artisan cheese course, have you changed any pro... Yes Is Selected

Explain what procedures or behaviors you have changed regarding environmental monitoring and testing since completing the course and why.

Display This Question:

If Environmental monitoring: Since you completed the artisan cheese course, have you changed any pro... No, and I do not intend to Is Selected

Explain why you did not change any procedures or behaviors related to environmental monitoring and testing programs after completing the course.

Display This Question:

If Environmental monitoring: Since you completed the artisan cheese course, have you changed any pro... No, but I intend to Is Selected

Explain what changes you intent to bring in the environmental pathogen monitoring and testing program in your facility since you completed the training and why.

Appendix H: Design Document for Lesson 3

Food Safety Basics for Artisan Cheesemakers: Lesson 3

1. Lesson 3

1.1 Course Title

Notes:

1.2 Lesson 3: Food Safety Hazards

Notes:

Welcome to Lesson 3 of the Food Safety Basics for Artisan Cheesemakers course. In this lesson, you will learn about food safety hazards-with a special focus on microbial pathogens that are of particular importance to artisan cheesemakers. This will put all the other modules into context, as we study how to protect your products and facility from these hazards.

1.3 Learning Objectives

Notes:

This lesson categorizes food safety hazards into broad groups much like regulatory agencies do. After completing this lesson, you will be able to list those general groups and categorize any food hazard into one of them.

We will discuss bacteria at a very high level--not too many details, but enough for you to begin to understand what you'll need to control in your processing facility. At the end of the lesson, you will be able to identify six factors that affect bacterial growth.

We will discuss high-risk biological contaminants that all cheese processing facilities must guard against. You will be able to name four of those biological pathogens, describe their characteristics, and explain how they grow and affect people.

Finally, you will learn what conditions are favorable for those high-risk pathogens, and you will be able to describe conditions and locate areas that are high-risk for *Listeria, E. coli, Salmonella and Staphylococcus*.

1.4 Hazards-You Guess

Notes:

Which of the following could be hazardous in a food processing facility? Once you have decided, roll over the items to check your answers.

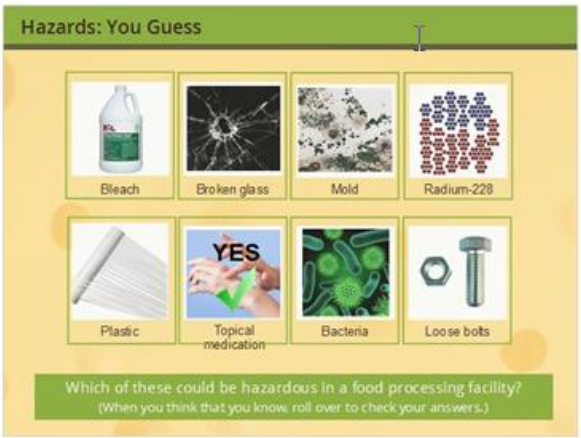
Bleach (Slide Layer)

Glass (Slide Layer)

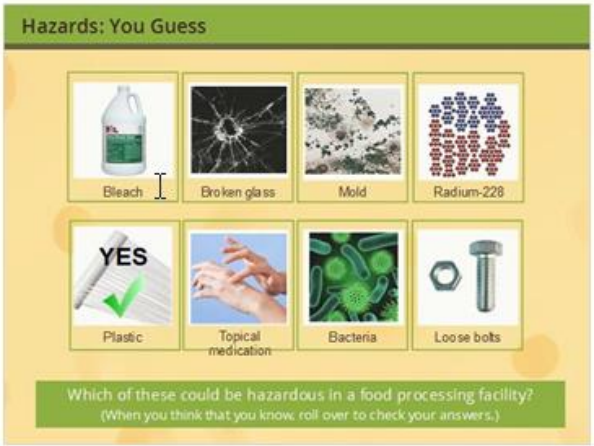
Mold (Slide Layer)

Radium-228 (Slide Layer)

Topical Med (Slide Layer)



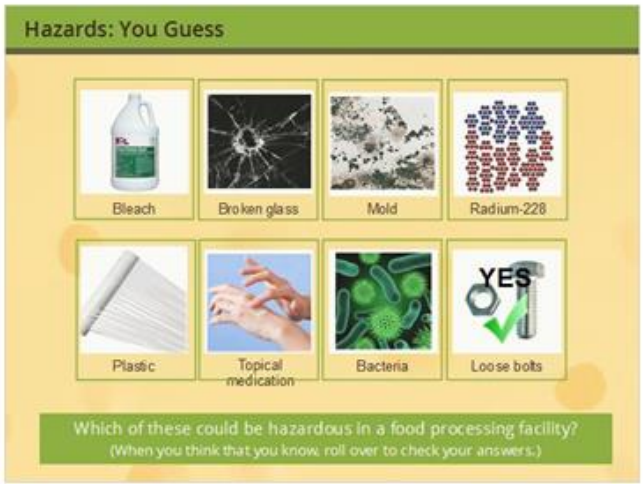
Plastic (Slide Layer)



Yeast (Slide Layer)

Bacteria (Slide Layer)

Bolt (Slide Layer)



1.5 Categories of Hazards

Notes:

Were you surprised that any of the examples were considered hazards?
These examples, as well as all food hazards, can be classified into broad categories. The most common ones are:
Physical hazards
Chemical hazards, and
Microbial or biological hazards Apart from these, there is another category that constitutes a food safety risk: Radiological hazard. Water used in a food facility is considered the viable vehicle for a radiological hazard. Even though radiological issues are rare in the food industry, businesses should be aware of their proximity to, and use of municipal or well-water sources that may be vulnerable to radiation in events such as extreme weather conditions.
Let's take a detailed look at the more common hazard categories.

1.6 Physical Hazards

Notes:

Physical hazards include foreign objects in food that can cause harm when eaten.
Physical hazards could be brought in from outside of the production room or facility -- things like packaging, plastic, and wooden splinters. They may also be found within the facility -- things like glass, bolts, buttons, fingernails, pens, and jewelry.
Here's an interesting fact: The FDA Health Hazard Evaluation Board found that over half of objects between 1 and 6 millimeters in size could cause an acute health hazard. One millimeter is the thickness of a dime!

1.7 Chemical Hazards

Notes:

Chemical hazards include compounds such as antibiotic residues, allergens, cleaners, sanitizers, lubricants, topical medications and lotions.
Chemical hazards are chemical agents that can cause illness or injury due to immediate or long-term exposure. For example, undeclared allergens in food products can send a consumer into anaphylactic shock. In fact, undeclared allergens are the number one cause of food recall events.

1.8 Hazards?

Notes:

Which of these are food safety hazards? When you think you know, roll over each image to check yourself.

Hair (Depends) (Slide Layer)

Dirt or Filth (Depends) (Slide Layer)

Insects (Depends) (Slide Layer)

1.9 Food Safety and Defect Action Levels

Notes:

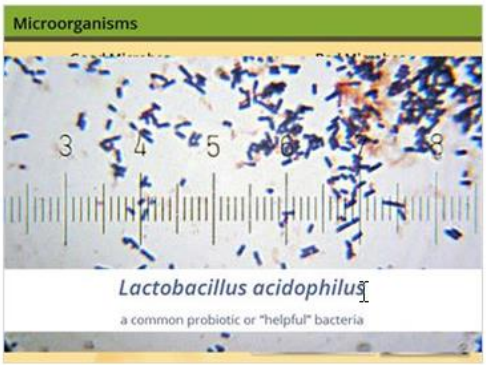
The majority of food safety hazards are biological, chemical or physical agents that are likely to cause illness or injury if eaten.

The contaminants you just rolled over are highly undesirable and should be controlled in any food processing facility. But some of these materials are unavoidable. They may be naturally found where certain ingredients are harvested, and so there is a chance that they will end up in finished products. Take walnuts, for example. Dirt, bugs or bug parts may be harvested along with walnuts because walnut trees are typically grown in open environments. For these natural or unavoidable defects, the FDA has clearly defined Defect Action Levels, which list the maximum allowable levels of these materials. We won't split hairs about what is a "hazard" versus a "quality issue;" but it is worth mentioning again that a food safety hazard is anything present in food with the potential to harm a consumer by causing illness or injury.

Click the button to learn more about defect action levels and to access the FDA's Defect Action Levels Handbook.

Defect Action Levels Handbook (Slide Layer)

1.10 Microorganisms



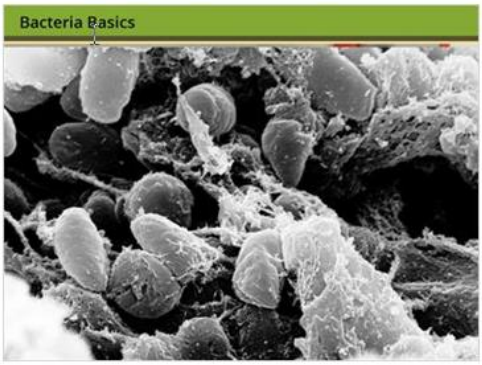
Notes:

Before we turn to bacterial pathogens that are of particular importance in the cheesemaking industry, let's go over a few basics about microorganisms.

Most microbes are harmless or even of great benefit to the world. We can broadly categorize them as "good" and "bad."

Beneficial microbes are the kinds of yeasts, molds and bacteria that help make cheese, sour cream, yogurt and other fermented dairy products. We add these microorganisms to our foods intentionally. They cause no harm.
The bad microbes are those that cause spoilage and foodborne illness.

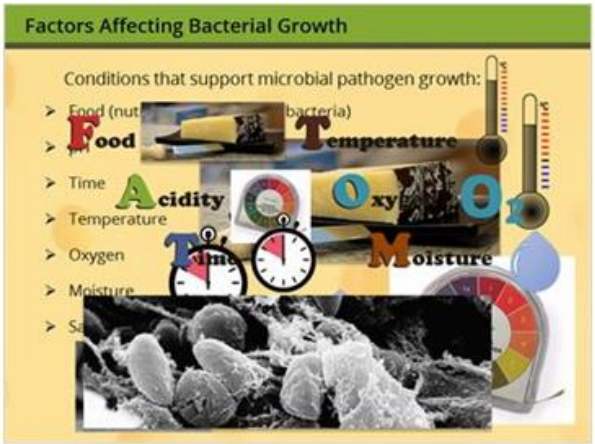
1.11 Bacteria Basics



Notes:

Bacteria are single-celled microorganisms that exist in a range of habitats. They can live in soil, water and even dust particles in the air! They also live symbiotically in and on all animals and humans. Basically, they're everywhere, so cheesemakers need to know how to avoid the bad ones.

1.12 Factors Affecting Growth



Notes:

Many factors affect bacterial growth, but the most important ones in terms of how we can control them in our cheesemaking facilities are: food, water, pH, time, temperature, oxygen and salt. These factors will make more sense when we can put them into context with the processing and preventive controls in the next two lessons. It's important now, however, to know that we must pay attention to these factors when we study specific pathogens as they relate to cheese production.

A common mnemonic used to remember conditions that support growth of microbial pathogens is "Fat Tom".

F is for food or the nutrients that feed the pathogens. Pathogens need a source of food in order to grow. Proteins that are readily available in all cheeses, feed any pathogens that are present.

A is for acidity or pH. Pathogens grow best in foods with little or no acidity. Think "neutral pH."

T is for time. Pathogens needs time to grow. A single bacterium can multiply exponentially in just a few hours.

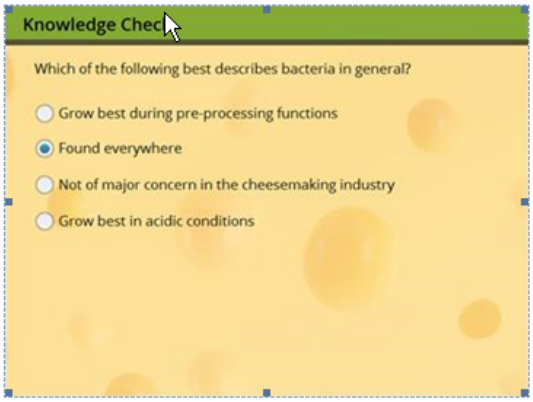
The next T is for temperature. The "temperature danger zone" in the food industry is between 41ºF (5ºC) and 135ºF (57ºC). It's called the danger zone because this is the temperature range that pathogens grow best.

O is for oxygen. Pathogens can grow with or without oxygen. in other words, some pathogens need oxygen to grow, others do not.

M is for moisture. All pathogens need moisture to grow.

1.13 Knowledge Check

(Multiple Choice, 10 points, 1 attempt permitted)



Correct	Choice
	Grow best during pre-processing functions
X	Found everywhere
	Not of major concern in the cheesemaking industry
	Grow best in acidic conditions

Feedback when correct:

That's right! Bacteria are single-celled microorganisms that live basically everywhere. Pathogenic bacteria can grow in a wide range of conditions.

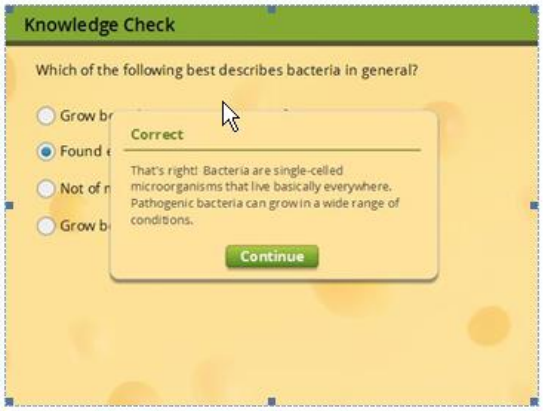
Feedback when incorrect:

No, the correct response is "found everywhere." Pathogenic bacteria grow in a wide range of conditions. You will learn more about how to control for pathogenic bacteria in later lessons.

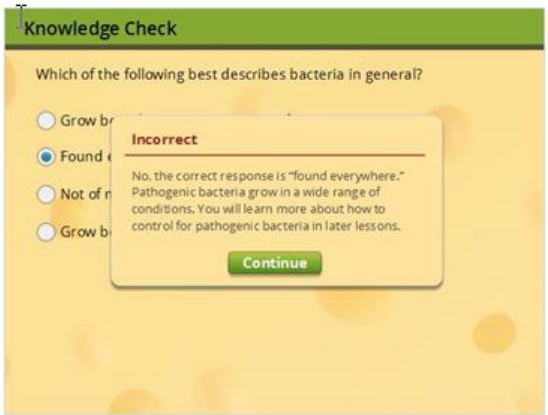
Notes:

Which of the following best describes pathogenic bacteria in general?

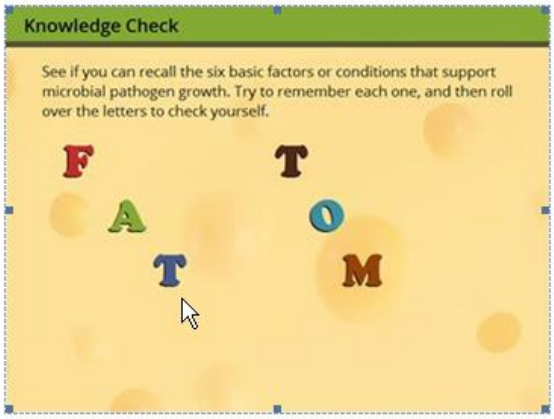
Correct (Slide Layer)



Incorrect (Slide Layer)



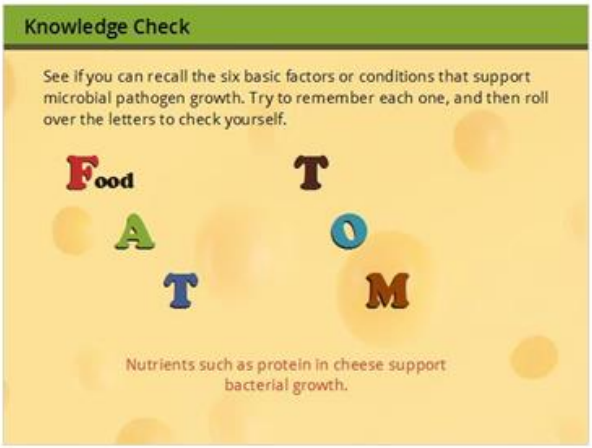
1.14 Knowledge Check



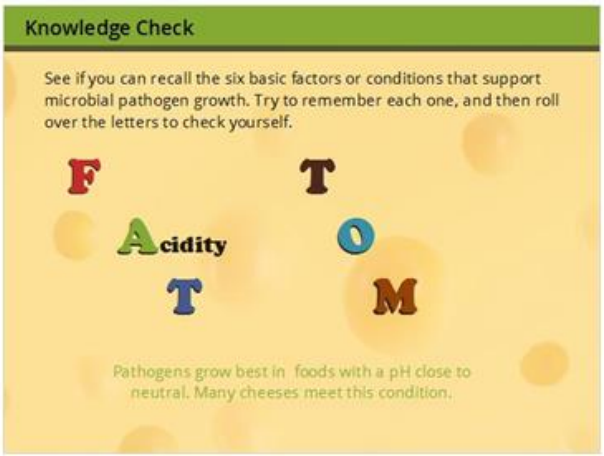
Notes:

Try to recall the six basic factors that support microbial growth. Roll over each letter to check yourself.

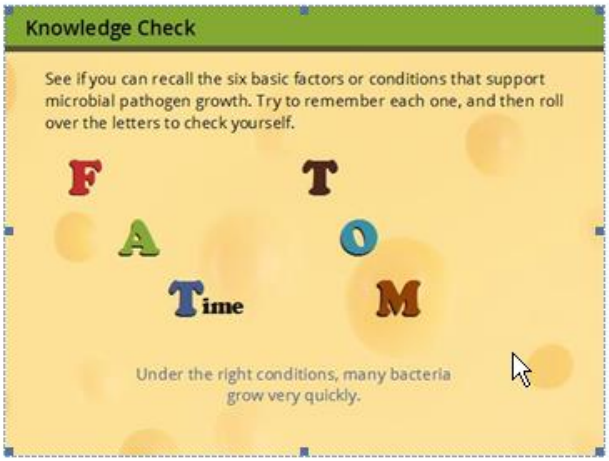
Food (Slide Layer)



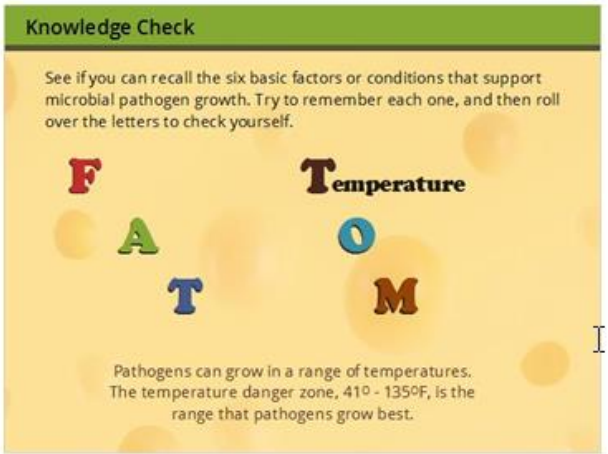
Acidity (Slide Layer)



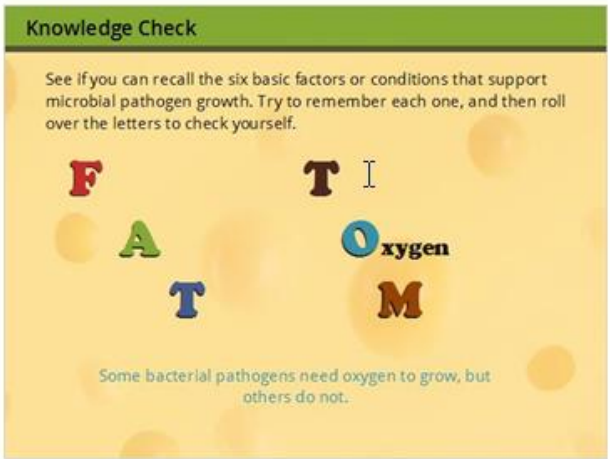
Time (Slide Layer)



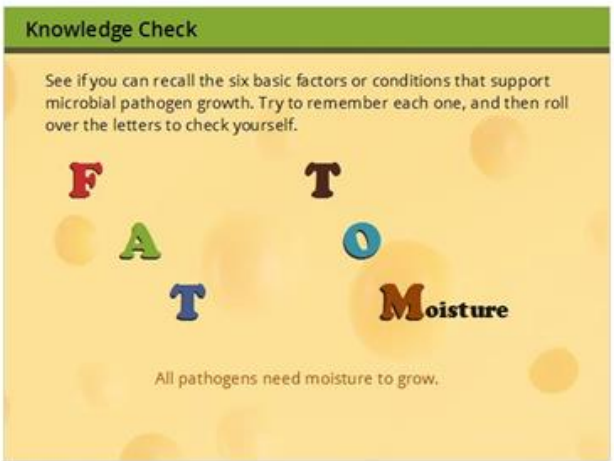
Temperature (Slide Layer)



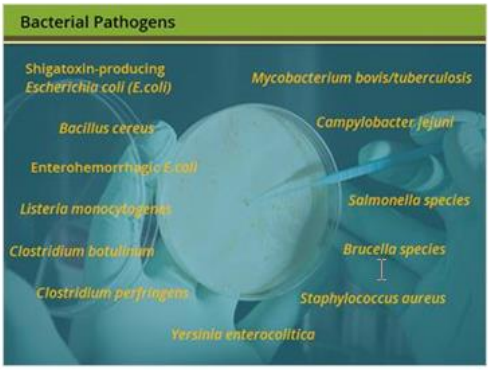
Oxygen (Slide Layer)



Moisture (Slide Layer)



1.15 Bacterial pathogens



Notes:

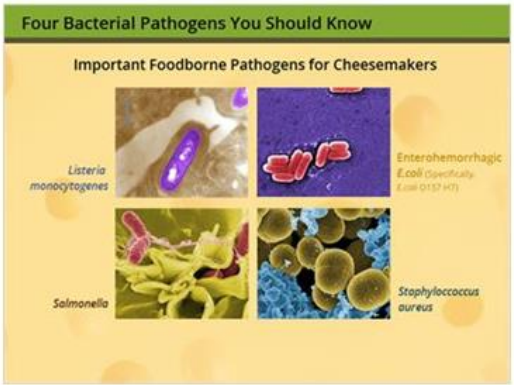
1.15a

These are some of pathogenic bacteria-the bad ones-that can cause food safety issues in the cheese industry. {short pause} You can see there're a lot of them, but we'll focus on just a few.

1.15b

There are many types of pathogenic bacteria that can cause food safety issues in the cheese industry, but there are a few of particular importance.

1.16 Four Bacterial Pathogens



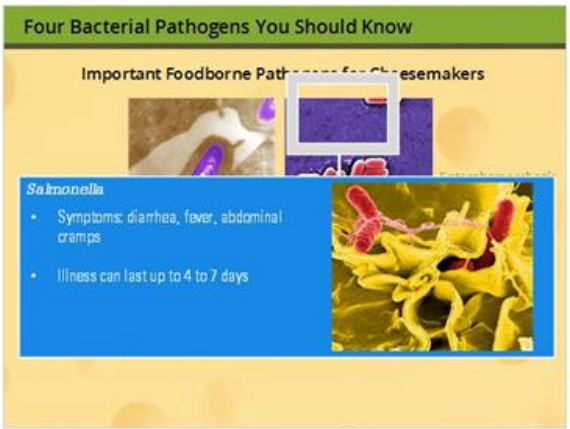
Notes:

Four bacterial pathogens you need to remember are: Listeria monocytogenes, E.coli O157:H7, Salmonella, and Staphylococcus aureus. Let's learn where we find these bacteria and the symptoms people experience when they make people sick.

Listeria -Cheese (Slide Layer)

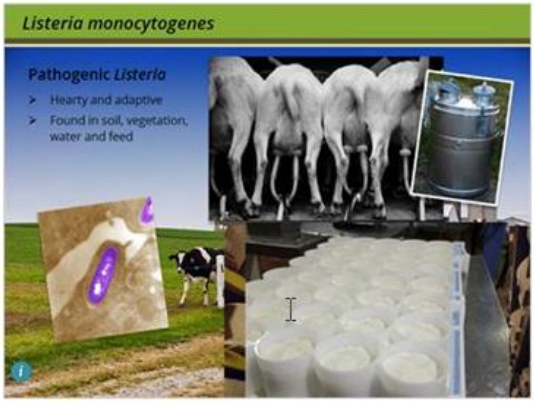
E.coli - Cheese (Slide Layer)

Salmonella - Cheese (Slide Layer)



Staphylococcus - Cheese (Slide Layer)

1.17 Listeria monocytogenes



Notes:

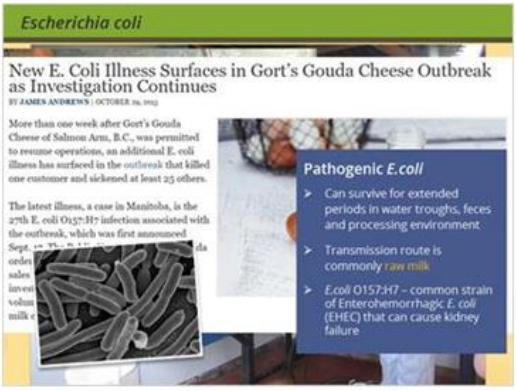
Listeria is a gram-positive rod-shaped bacteria with round ends. *Listeria* is present in the environment and has the ability to grow in many different places. The major human pathogen in the *Listeria* genus is *Listeria monocytogenes*. Because *Listeria monocytogenes* is so hearty and adaptive, it's pretty much everywhere on a dairy farm. It is in the soil and vegetation; it can be in the water that our cows, goats, and sheep drink; it can be in the feed they eat, and therefore their feces. Once it gets into the processing environment, it can hide unnoticed in food-processing equipment and contaminate food during production and processing. It is difficult to control in food processing rooms that are cool and moist because it can grow under these conditions. It can grow with or without oxygen and even at refrigeration temperatures! *Listeria monocytogenes* can also be present in raw milk.

1.18 Listeriosis

Notes:

A person who eats food contaminated with Listeria monocytogenes can get a serious infection called listeriosis. According to the CDC, "Listeria is the third-leading cause of death from food poisoning, killing 1 out of 5 people it infects."
You may hear or read elsewhere that it is rare for people to be infected by Listeria. This is because it affects only a "small percentage" of the U.S. population. However, this equates to about 1600 Americans suffering from Listeriosis every year.
Listeriosis can cause fever, muscle aches, headache, stiff neck, loss of balance, and sometimes vomiting and diarrhea.
Pregnant women, young children, the elderly, and persons with weakened immune systems are at higher risk to suffer serious consequences of listeriosis.
The incubation period for Listeria monocytogenes is from 3-70 days. Symptoms can persist for days to weeks depending on the individual's overall health.

1.19 E.coli



Notes:

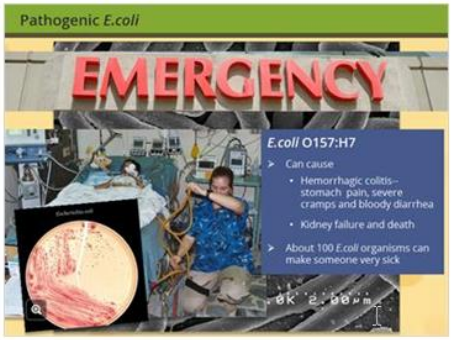
Escherichia coli is a gram-negative, rod-shaped bacteria commonly found in the lower intestine of warm-blooded organisms, such as cows, goats, sheep and pigs.

Most E. coli are harmless, but some types can cause people to become very sick, and are occasionally responsible for product recalls due to food contamination.

Pathogenic E.coli can survive for extended periods outside its host, in water troughs, feces, and the processing environment. The most common route of transmission to a dairy facility is from raw milk and cross contamination from the farming environment.

The most common pathogenic E. coli associated with cheesemaking environments are those that are classified into a category called Enterohemorrhagic E. coli, or EHEC. E.coli O157:H7 is the most common type of E.coli in the EHEC category.

1.20 Pathogenic E.coli



Notes:

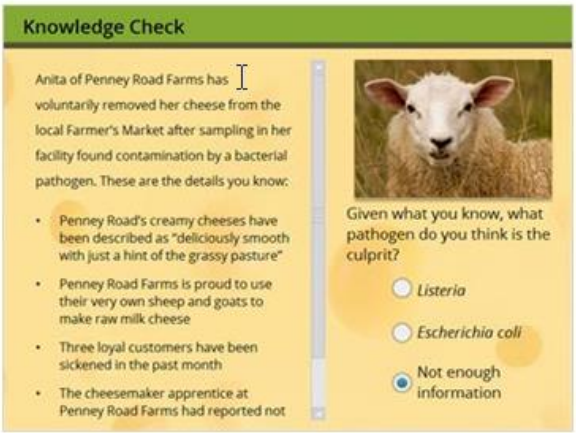
E.coli O157:H7 can cause an acute disease called hemorrhagic colitis, which is characterized by sudden onset of stomach pain, severe cramps, and bloody diarrhea. Sometimes there is vomiting, but generally no fever. A small percentage of people infected with E.coli get a much more serious condition that can cause kidney failure and even death.

Unlike many infectious bacteria, where it takes tens of thousands of organisms to make someone sick, it only takes about 100 E.coli cells to make someone sick or even send them to the hospital.

E. coli has an incubation period of 3-4 days and usually persists for 1-10 days. It is present in 2-5% of bulk raw milk.

1.21 Knowledge Check

(Multiple Choice, 10 points, 1 attempt permitted)

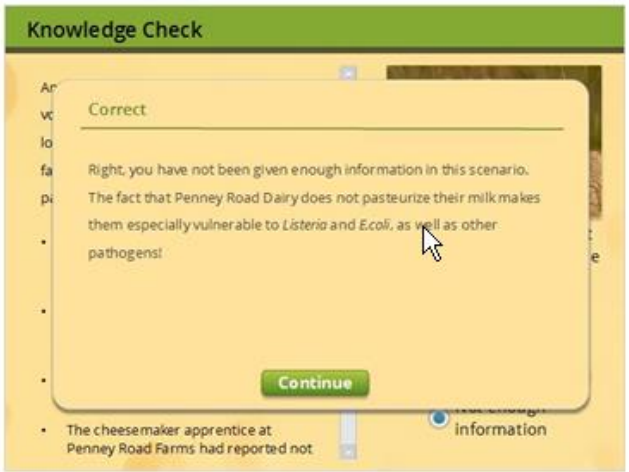


Correct	Choice	Feedback
	Listeria	It could be Listeria, but you have not been given enough information to know for sure. The symptoms of people suffering from foodborne illness due to Listeria or E.coli could be similar-for example, stomach pain and diarrhea. The fact that Penney Road Dairy does not pasteurize their milk makes them especially vulnerable to both pathogens, as well as others.
	Escherichia coli	It could be E.coli, but you have not been given enough information to know for sure. The symptoms of people suffering from foodborne illness due to Listeria or E.coli could be similar-for example, stomach pain and diarrhea. The fact that Penney Road Dairy does not pasteurize their milk makes them especially vulnerable to both pathogens, as well as others.
X	Not enough information	Right, you have not been given enough information in this scenario. The fact that Penney Road Dairy does not pasteurize their milk makes them especially vulnerable to Listeria and E.coli, as well as other pathogens!

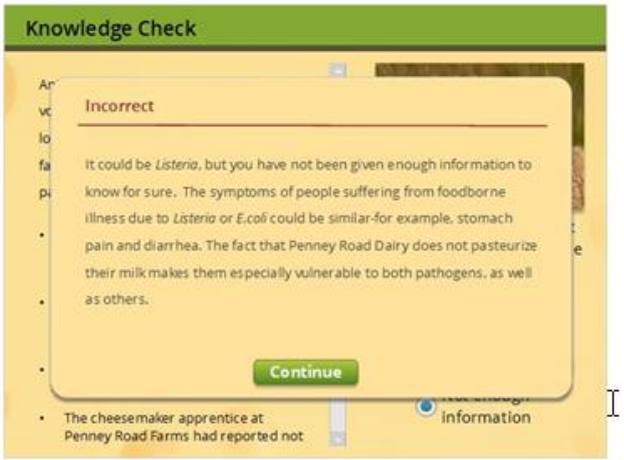
Notes:

Anita of Penney Road Farms has voluntarily removed her cheese from the local Farmer's Market after sampling in her facility found contamination by a bacterial pathogen. Read the details given and use what you've learned in this lesson to select which pathogen is the one most likely found.

Not enough information (Slide Layer)



Listeria (Slide Layer)



Escherichia coli (Slide Layer)

1.22 Knowledge Check

(Multiple Choice, 10 points, 1 attempt permitted)

Correct	Choice
X	E.coli O157:H7
	Listeria monocytogenes
	Either E.coli O157:H7 or Listeria monocytogenes

Feedback when correct:

That's right! The short incubation time and raw cheese tell us that Becky was more likely sickened by E.coli (rather than by Listeria monocytogenes.)

Feedback when incorrect:

No, you did not select the correct response. The short incubation time and raw cheese tells us that Becky was most likely sickened by E.coli (and not by Listeria.)

Notes:

Becky ate raw cheese three days ago and is now experiencing stomach cramps and diarrhea. Which pathogen is most likely the culprit?

Correct (Slide Layer)

Incorrect (Slide Layer)

1.23 Salmonella

Notes:

Salmonella is a genus of gram-negative, rod-shaped bacteria that is commonly associated with foodborne illness worldwide. The species that most people are referring to when they say *Salmonella* is *Salmonella enterica*. The *Salmonella enterica* species is divided into subsets called serovars. There are over 2500 serovars that all can cause disease in people.

Salmonella is commonly found in soil, water and animal hosts. The bacteria inhabit the intestinal tract of *{~~warm blooded mammals~~}* farm animals *[sic]* such as poultry, cows and other livestock. The bacteria is easily transmitted through water, soil and fecal matter on a farm. Animals that *are infected shed large numbers of bacteria through feces, milk and saliva. Milk can be contaminated by unclean udders and teats. Like E.coli, the most common route into a cheese facility and cheese processing rooms is on people and through equipment that has not been properly cleaned and sanitized. Salmonella is found in ~2-5% of bulk raw milk.*

1.24 Salmonellosis

Notes:

Salmonella can cause serious and sometimes fatal infections in young children, frail or elderly people, and others with weakened immune systems. Healthy persons infected with *Salmonella* often experience fever, diarrhea (which may be bloody), nausea, vomiting, and abdominal pain. In rare circumstances, when *Salmonella* gets into someone's bloodstream, it can produce more severe illnesses. Doctors commonly treat this infection with antibiotics.

1.25 Staphylococcus aureus

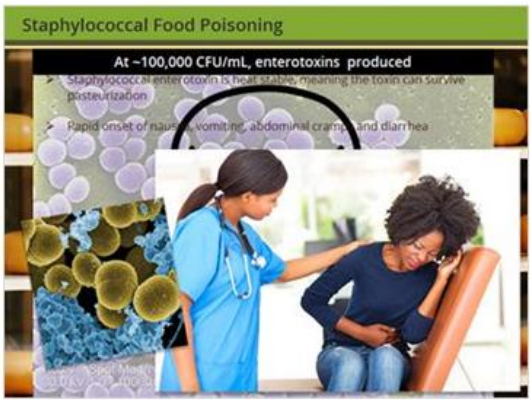
Notes:

Staphylococcus aureus is a gram-positive, round-shaped bacteria that is found in all known species of mammals, including people. It is readily transmitted from one species to another. *Staphylococcus aureus* is spread through direct contact with objects or animals that are contaminated with the bacteria, as well as through the air.

Raw milk provides ideal growth conditions for *Staphylococcus aureus*.

Dairy animals may not show symptoms of carrying *Staphylococcus aureus*, even when they have infection of their mammary glands. Then, the bacteria can easily be transmitted into the dairy facility through contaminated milking equipment. It can also be transmitted directly from workers to dairy products, as *Staphylococcus aureus* is carried by 30-50% of humans in their nose and on their hair and skin.

1.26 Staphylococcal Food Poisoning



Notes:

If *Staphylococcus aureus* contaminates a food, such as cheese, and that food is not refrigerated--for example, sitting in an aging room-- the bacteria will begin to grow. As *Staphylococcus aureus* consumes the nutrients in the food, and when the population reaches around 100,000 colony forming units per milliliter (CFU/mL), it excretes a *heat stable* toxin known as Staphylococcal enterotoxin. The fact that this toxin is heat stable means that the toxin survives pasteurization, even if the bacterial cells do not.

Staphylococcal food poisoning involves rapid onset of nausea, vomiting, abdominal cramps and diarrhea. The severity of the illness depends on how much toxin is ingested, how susceptible an individual is to the toxin, and their overall health. The incubation period for *Staphylococcus aureus* is 1-6 hours. Duration of illness is usually 1-2 days.
Bulk tank counts for *Staphylococcus aureus* should be less than 100 to 500 CFU/ml.

1.27 Biofilms

Notes:

Some bacteria proliferate in biofilms. What does this mean and why is it important?
Biofilms can be a serious problem in many food industry sectors because they get on food contact surfaces and they're difficult to remove.
Biofilms are the most common bacterial lifestyle in nature. After initial attachment of cells to a surface, each bacterium begins to multiply and secrete a consistent matrix of extracellular polymeric substances (or EPS) in which cells are wrapped. The protective layer of EPS is resistant to antimicrobials and disinfection.

Of the bacteria we've just talked about, *Listeria* and *Staphylococcus* grow in biofilms. These bacteria, as you've learned, can enter milk processing equipment by direct contact with contaminants in the dairy farm environment. They can also enter through water used in milking machines. Clean-in-place (CIP) procedures are usually used in milk processing lines, but their effectiveness is limited against residual microorganisms, which can regrow and form new biofilms.

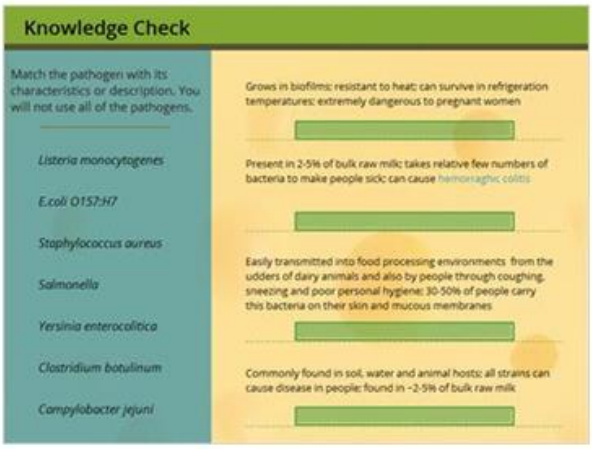
1.28 Continual Challenge

Notes:

Let's face it, it's not possible to eradicate all of the hazards which occur in nature. Your challenge as a cheesemaker is even more difficult because all of these pathogenic bacteria are very common on a farm, so food safety must begin there. After this lesson, we will begin focusing on the interventions that help control or minimize risks. For now, let's make sure you know the basics about the common hazards.

1.29 Knowledge Check - Pathogen Match

(Drag and Drop, 10 points, 1 attempt permitted)



Drag Item	Drop Target
Listeria monocytogenes	Drop-1
E.coli O157:H7	Drop-2
Staphylococcus aureus	Drop-3
Salmonella	Drop-4
Yersinia enterocolitica	
Clostridium botulinum	
Campylobacter jejuni	

Drag and drop properties
Snap dropped items to drop target (Snap to center)
Allow only one item in each drop target

Feedback when correct:

That's right! You correctly matched the pathogens with their descriptions and/or characteristics.

Feedback when incorrect:

No, you did not correctly match the pathogens with their descriptions and/or characteristics.

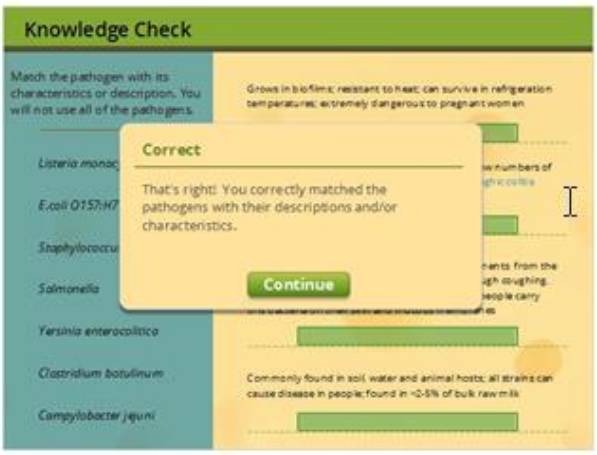
You will see the correct answer when you continue.

Notes:

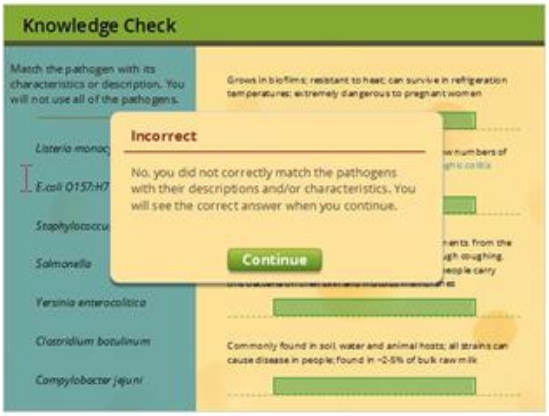
Match the bacterial pathogen with the given characteristics or description.

Drag the appropriate pathogen to the drop target under each description. You will only use four pathogens.

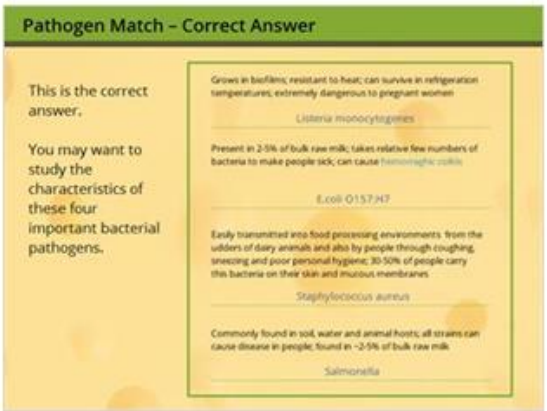
Correct (Slide Layer)



Incorrect (Slide Layer)



1.30 Pathogen Match – Correct Answer



Notes:

Study these descriptions or return to the lesson to review characteristics of these four important bacterial pathogens.

1.31 Summary

Notes:

- In this lesson you learned what characterizes a food safety hazard.
- You learned three categories of food safety hazards and saw examples.
- You learned about bacteria in general and important factors affecting their growth
- You learned specific characteristics of four important pathogenic organisms that are common in the cheese and dairy industry and symptoms of people sickened by them.

Complete the Knowledge Check practice exercises on the next slides to see if there is information you should review in the lesson.

Rollover for sanitizer label (Slide Layer)

1.32 Lesson Exit

Notes:

You have completed this lesson. Click the Exit button to close it.

2. Lesson 4

2.1 Acknowledgements & Disclaimer

Acknowledgements

The subject matter for this online course is based on a face-to-face workshop developed by Dr. Dennis D'Amico at the University of Connecticut and the Vermont Institute for Artisan Cheese at the University of Vermont. This workshop was offered through the support of the Innovation Center for U.S. Dairy.

NC State University curated the workshop materials and created this online course in collaboration with the Center for Dairy Research at the University of Wisconsin, Dairy Foods Extension program at Cornell University and an "Artisan Advisory Group" that included representatives from Jasper Hill Farm, Clock Shadow Creamery, The Ice Cream Club, Dairy Connection, Schreiber Foods, the American Cheese Society, SYSCO Foodservices and Whole Foods.

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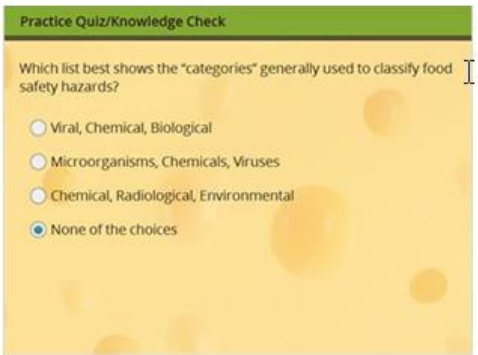
Notes:

1. Question Bank 1

Q1.1 Knowledge Check

(Multiple Choice, 15 points, 1 attempt permitted)



Correct	Choice
	Viral, Chemical, Biological
	Microorganisms, Chemicals, Viruses
	Chemical, Radiological, Environmental
X	None of the choices

Feedback when correct:

That's right! Food regulators generally categorize safety hazards as Physical, Chemical or Biological. Radiological Hazards in relation to your facility's water source were also mentioned as something that cheesemakers should be aware of.

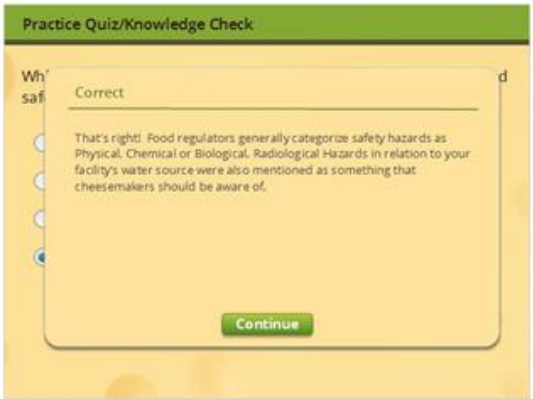
Feedback when incorrect:

No, you did not select the correct response.

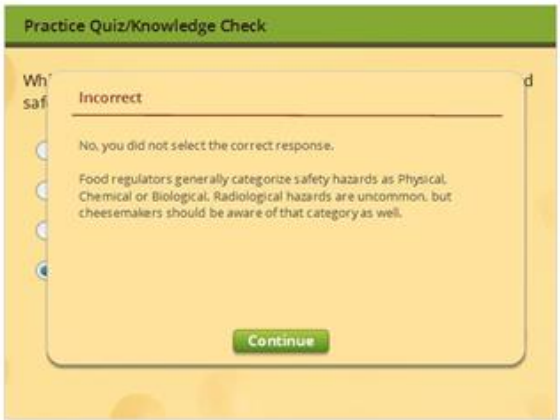
Food regulators generally categorize safety hazards as Physical, Chemical or Biological. Radiological hazards are uncommon, but cheesemakers should be aware of that category as well.

Notes:

Correct (Slide Layer)

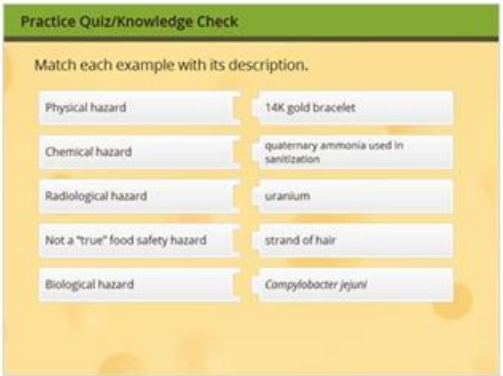


Incorrect (Slide Layer)



Q1.2 Knowledge Check

(Matching Drag-and-Drop, 20 points, 1 attempt permitted)



Correct	Choice
Physical hazard	14K gold bracelet
Chemical hazard	quaternary ammonia used in sanitization
Radiological hazard	uranium
Not a "true" food safety hazard	strand of hair
Biological hazard	Campylobacter jejuni

Feedback when correct:

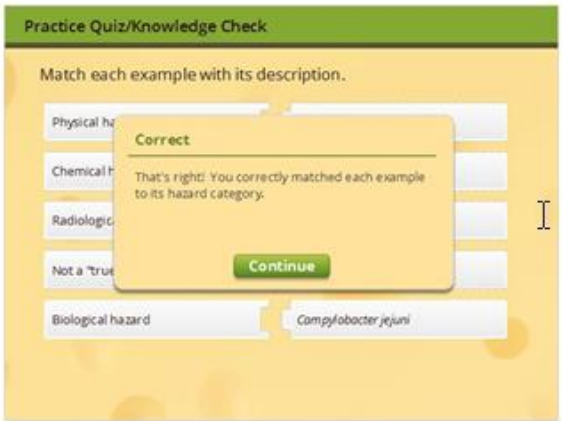
That's right! You correctly matched each example to its hazard category.

Feedback when incorrect:

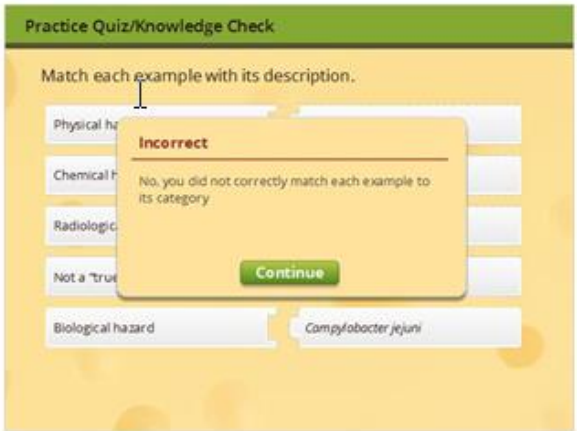
No, you did not correctly match each example to its category

Notes:

Correct (Slide Layer)

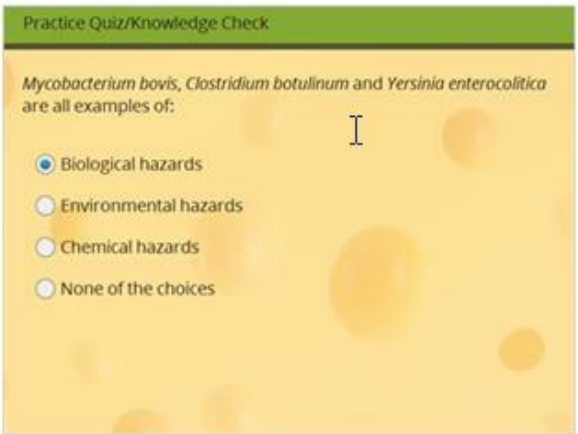


Incorrect (Slide Layer)



Q1.3 Knowledge Check

(Multiple Choice, 10 points, 1 attempt permitted)



Correct	Choice
X	Biological hazards
	Environmental hazards
	Chemical hazards
	None of the choices

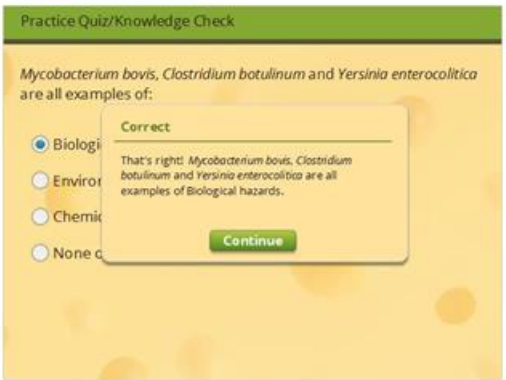
Feedback when correct:

That's right! Mycobacterium bovis, Clostridium botulinum and Yersinia enterocolitica are all examples of Biological hazards.

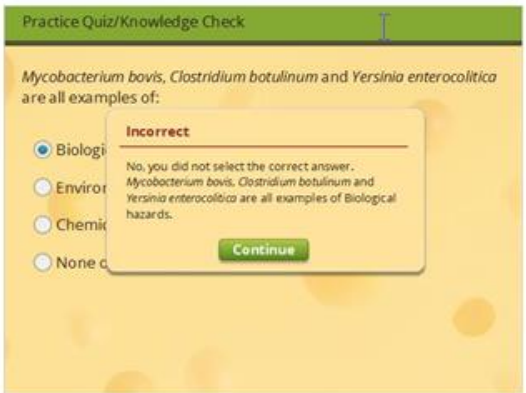
Feedback when incorrect:

No, you did not select the correct answer. Mycobacterium bovis, Clostridium botulinum and Yersinia enterocolitica are all examples of Biological hazards.

Correct (Slide Layer)

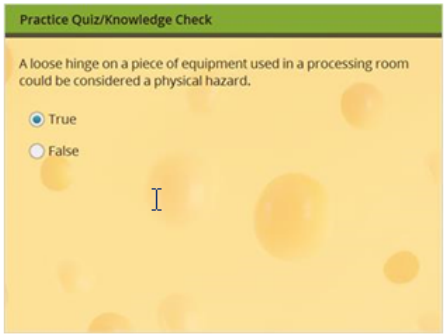


Incorrect (Slide Layer)



Q1.4 Knowledge Check

(True/False, 10 points, 1 attempt permitted)



Correct	Choice
X	True
	False

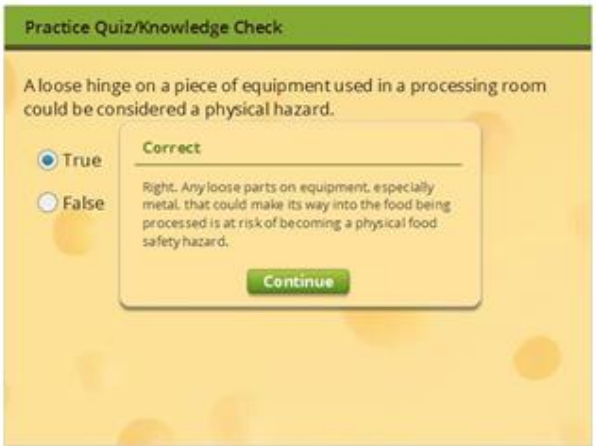
Feedback when correct:

Right. Any loose parts on equipment, especially metal, that could make its way into the food being processed is at risk of becoming a physical food safety hazard.

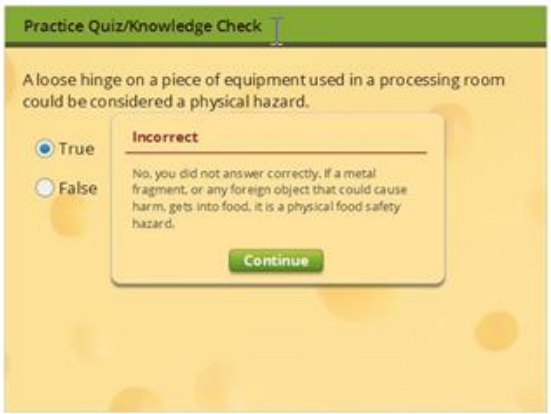
Feedback when incorrect:

No, you did not answer correctly. If a metal fragment, or any foreign object that could cause harm, gets into food, it is a physical food safety hazard.

Correct (Slide Layer)

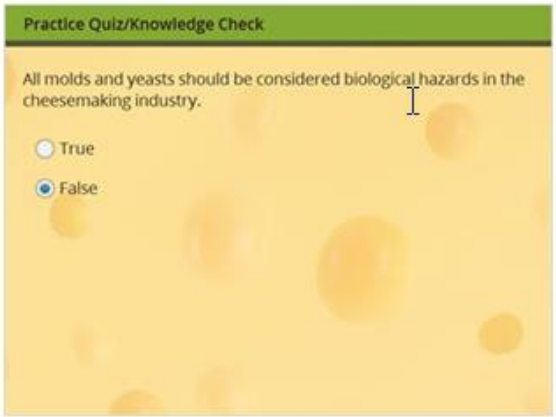


Incorrect (Slide Layer)



Q1.5 Knowledge Check

(True/False, 15 points, 1 attempt permitted)



Correct	Choice
	True
X	False

Feedback when correct:

Right. Yeast and mold can cause foods to spoil. Some molds can form toxins that can cause illness, but some molds are used to make certain kinds of cheeses such as Roquefort, Blue, Gorgonzola, and Stilton. Therefore, we must know more about the yeast or mold to call it a food safety hazard.

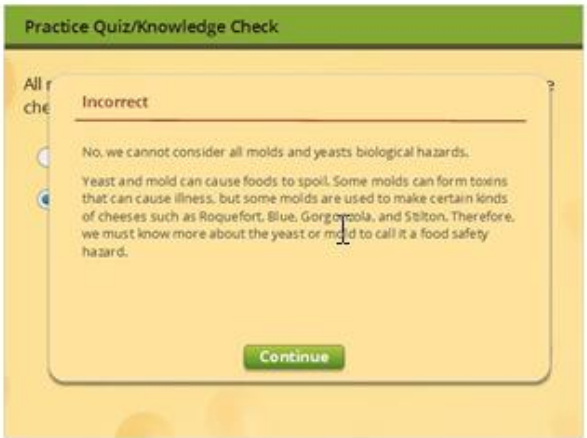
Feedback when incorrect:

No, we cannot consider all molds and yeasts biological hazards.

Yeast and mold can cause foods to spoil. Some molds can form toxins that can cause illness, but some molds are used to make certain kinds of cheeses such as Roquefort, Blue, Gorgonzola, and Stilton. Therefore, we must know more about the yeast or mold to call it a food safety hazard.

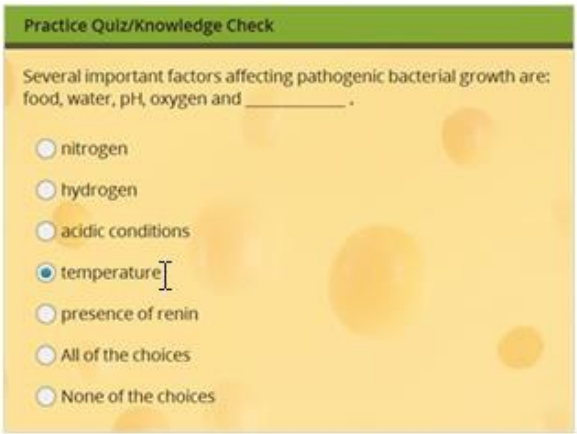
Correct (Slide Layer)

Incorrect (Slide Layer)



Q1.6 Knowledge Check

(Multiple Choice, 10 points, 1 attempt permitted)



Correct	Choice
	nitrogen
	hydrogen
	acidic conditions
X	temperature
	presence of renin
	All of the choices
	None of the choices

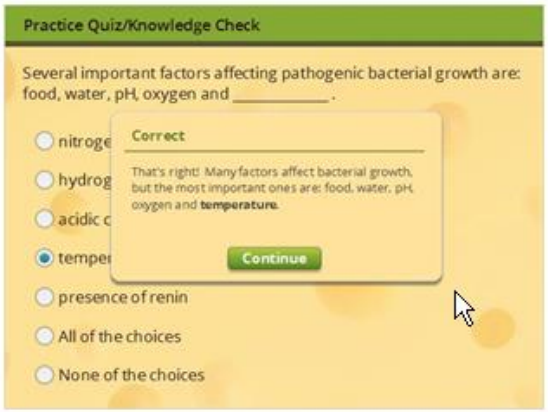
Feedback when correct:

That's right! Many factors affect bacterial growth, but the most important ones are: food, water, pH, oxygen and temperature.

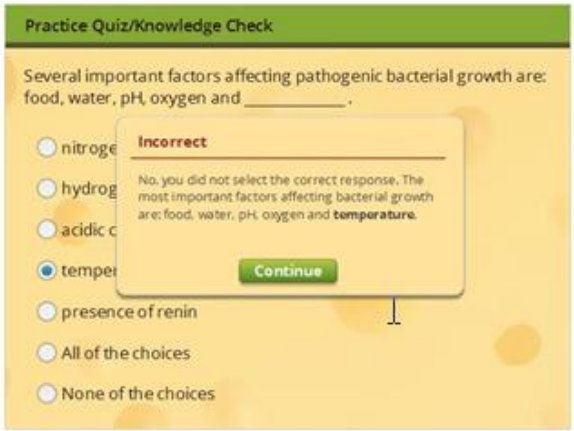
Feedback when incorrect:

No, you did not select the correct response. The most important factors affecting bacterial growth are: food, water, pH, oxygen and temperature.

Correct (Slide Layer)

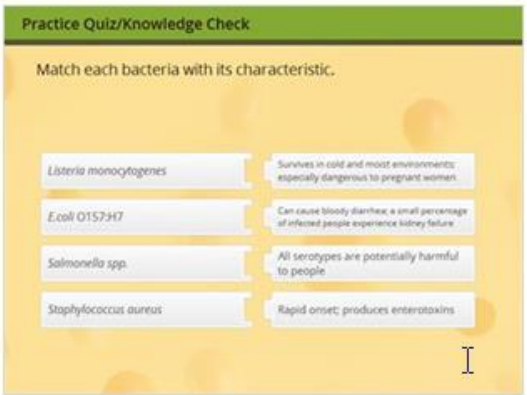


Incorrect (Slide Layer)



Q1.7 Match each bacteria with its characteristic.

(Matching Drag-and-Drop, 20 points, 1 attempt permitted)



Correct	Choice
Listeria monocytogenes	Survives in cold and moist environments; especially dangerous to pregnant women
E.coli O157:H7	Can cause bloody diarrhea; a small percentage of infected people experience kidney failure
Salmonella spp.	All serotypes are potentially harmful to people
Staphylococcus aureus	Rapid onset; produces enterotoxins

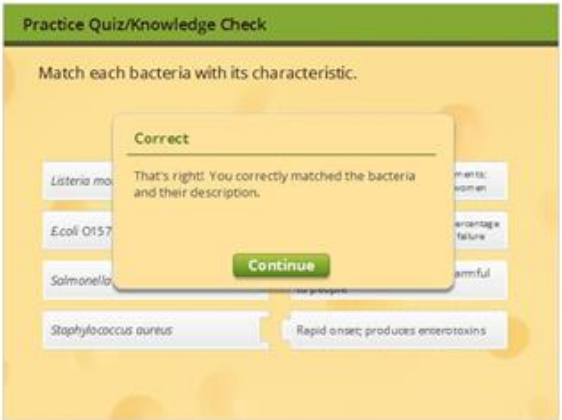
Feedback when correct:

That's right! You correctly matched the bacteria and their description.

Feedback when incorrect:

You did not correctly match each bacteria and the given description.

Correct (Slide Layer)



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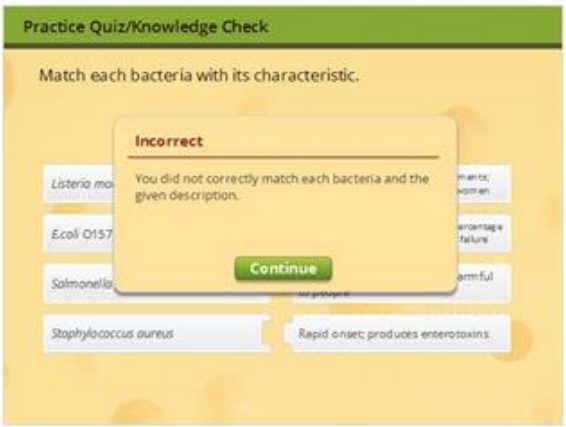

Appendix I: Quiz Questions

WolfWare / Dashboard / My courses / Food Safety Basics for Artisan Cheesemakers / Lesson 1: Importance of Food Safety / Quiz 1 / Preview

Question 1
Not yet answered
Points out of 1.00
Flag question
Edit question

Select the best answer(s) that apply to the following statements.

1. The fact that raw milk contains microorganisms Choose... the food safety risks of food products made with milk.
2. Cheesemaking facilities located near or on dairy farms Choose... the food safety risks of food products made at these facilities.
3. Not investing the appropriate resources toward food safety Choose... the food safety risks in food processing facilities and products.

Question 2
Not yet answered
Points out of 1.00
Flag question
Edit question

Feta cheese has a water activity of approximately 0.95 and a pH of about 4.5, whereas Swiss cheese typically has a water activity of 0.97 and pH of 5.6. If you only consider water activity and pH and compare these two cheese varieties, you would expect the highest risk cheese to be Choose... .

Question 3

Not yet answered

Points out of 1.00

Flag question

Edit question

Which of the following statement(s) is true about Genome Trakr? Check all that apply.

Select one or more:

- [ ] a. It uses data from whole genome sequencing to identify pathogens associated with foodborne illness outbreaks.
- [ ] b. It uses data from whole genome sequencing to identify pathogens found in finished products.
- [ ] c. It uses data from whole genome sequencing to identify pathogens found in food processing environments.
- [ ] d. It makes it possible to detect the source of foodborne illness outbreaks by connecting genomic information about the pathogen involved with the geographic location of the outbreak.
- [ ] e. It is not a reliable and efficient method for detecting the source of a foodborne illness outbreak.

Question 4

Not yet answered

Points out of 1.00

Flag question

Edit question

An effective sanitation program will not only control pathogenic microorganisms, but it may also reduce or eliminate spoilage microorganisms.

Select one:

- ( ) True
- ( ) False

Question 5

Not yet answered

Points out of 1.00

Flag question

Edit question

Which of the following statements is true about food safety? Check all that apply.

Select one or more:

- [ ] a. A food safety management system is the result of developing and implementing a food safety plan.
- [ ] b. Food safety is the sole responsibility of the owner or managers of a food company.
- [ ] c. Food safety efforts can prevent food recalls and foodborne illness outbreaks.
- [ ] d. It is more important for big companies to have food safety programs than small companies.
- [ ] e. Food safety efforts improve the overall wholesomeness and quality of food products.
- [ ] f. Food safety involves regularly performing certain procedures that are designed to minimize or eliminate food safety hazards.

WolfWare / Dashboard / My courses / Food Safety Basics for Artisan Cheesemakers / Lesson 2: Standards and Regulations / Quiz 2 / Preview

Question 1

Not yet answered

Points out of 1.00

Flag question

Edit question

Match the following regulations and standards with the requirements that they describe

Federal regulation for implementation of Good Manufacturing Practices, conducting a hazard analysis, and implementing preventive controls in food processing plants that manufacture human foods.	Choose...
Federal regulation for food labels. Specifies how to communicate nutrition facts, a list of ingredients, etc.	Choose...
Documents the minimum standards for sanitation in milk processing facilities.	Choose...
Reference document that communicates food handling requirements in foodservice and food retail settings.	Choose...
Food safety standards initiated by certain grocery stores that artisan cheesemakers must comply with in order to do business with these stores.	Choose...

Question 2

Not yet answered

Points out of 1.00

Flag question

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Which title and chapter in the Code of Federal Regulations pertains to artisan cheesemakers and the topic of food safety?

Select one:

- a. Title 9 Chapter 1
- b. Title 21 Chapter 1
- c. Title 21 Chapter 3
- d. Title 21 Part 117

Question 3

Not yet answered

Points out of 1.00

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Which government organization regulates Good Manufacturing Practices?

Select one:

- a. United States Department of Agriculture (USDA)
- b. World Health Organization
- c. Environmental Protection Agency
- d. Food and Drug Administration
- e. Food and Drug Agency

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Question 1

Not yet answered

Points out of 1.00

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The most common root cause of food recalls is Choose... .

Question 2
Not yet answered
Points out of 1.00
Flag question
Edit question

The different types of chemical food safety hazards are: antibiotic residues, cleaners, sanitizers, lubricants, topical medications or lotion and Choose... .

Question 3
Not yet answered
Points out of 1.00
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Edit question

Which of the following pathogens is known for its reputation of being able to survive and grow in cool and moist environments?

Select one:

- a. *Listeria monocytogenes*
- b. *E. coli* 0157:H7
- c. *Salmonella* species
- d. *Clostridium botulinum*

Question 4
Not yet answered
Points out of 1.00
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Which is of the following pathogens is the leading cause of food poisoning resulting from the consumption of foods containing enterotoxin?

Select one:

- A. *Clostridium perfringens*
- B. *Clostridium botulinum*
- C. *Staphyloccous aureus*
- D. *Escherichia coli*

Question 5
Not yet answered
Points out of 1.00
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Implementing effective sanitation practices AND controlling the pH, temperature, and water activity in finished products are basic techniques for controlling which of the following types of food safety hazard? Check all that apply.

Select one or more:

- A. Biological
- B. Chemical
- C. Physical

Question 6
Not yet answered
Points out of 1.00
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Which of these are considered physical food safety hazards?

Select one:

- A. Glass shards
- B. Bolts
- C. Saw blade pieces
- D. Bone fragments
- E. Metal shavings
- F. All of the above
- G. A, B & C

Question 7
Not yet answered
Points out of 1.00
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Which of the following statements is true about the symptoms of listeriosis?

Select one:

- A. The condition causes flu-like symptoms and may lead to miscarriage, stillbirth, premature delivery, and infections in newborns.
- B. Immediate nausea and vomiting are experienced after ingesting the contaminated food.
- C. The condition affects the general population at a greater rate than it affects pregnant women.
- D. Cooking meats to an internal temperature of 165°F or higher does not eliminate the bacteria.

Question 8
Not yet answered
Points out of 1.00
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Which set of pathogens are most relevant to food safety in cheese making facilities?

Select one:

- A. Norovirus, *Bacillus cereus, Clostridium perfringens, Listeria monocytogenes*
- B. *Escherichia coli, Staphyloccous aureus, Campylobacter jejuni*, and Norovirus .
- C. *Staphyloccous aureus, Listeria monocytogenes, Escherichia coli* 0157:H7, and *Salmonella* spp.
- D. *Campylobacter jejuni, Vibrio cholerae, Clostridium botulinum, Salmonella* and spp.

Question 9
Not yet answered
Points out of 1.00
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The different types of chemical food safety hazards are : Antibiotic residues, Cleaners, Sanitizers, Lubricants, Topical medications or lotion and _____.

Select one:

- A. Wooden chip
- B. Allergens
- C. Aflatoxin
- D. None of these are chemical hazards

Question 10
Not yet answered
Points out of 1.00
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Edit question

Insect parts are considered to be a food safety hazard if they are below the defect action level.

Select one:

- True
- False

Question 1
Not yet answered
Points out of 1.00
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Sanitation is most effectively executed when surfaces are sanitized Choose... they are cleaned.

Choose...
before
after

Question 2
Not yet answered
Points out of 1.00
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Edit question

Which of the following best describes pre-requisite programs and Good Manufacturing Practices?

Select one or more:

- [ ] a. A step where a control is applied which is essential to prevent or eliminate a food safety hazard
- [ ] b. Basic conditions or practices followed by food manufacturing companies to help prevent food safety hazards
- [ ] c. Written procedures necessary to ensure sanitary conditions in a processing facility
- [ ] d. Programs that should be developed and implemented after a food safety plan is developed and implemented

Question 3
Not yet answered
Points out of 1.00
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Per 21 CFR 117.4, each person working in a food manufacturing facility must

Select one:

- ( ) a. Have the education, training or experience to perform their assigned duties.
- ( ) b. Attend at least one PCQI workshop annually.
- ( ) c. Sign appropriate documentation that they are adequately qualified for their job.

Question 4

Not yet answered

Points out of 1.00

Flag question

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Which basic hygiene practices should every worker follow? Select all that apply.

Select one or more:

- a. Wear gloves and keep them clean and sanitized.
- b. Keep clothing clean to avoid cross contamination.
- c. Wear a watch so that you know when to take breaks.
- d. Wear a smock or apron with pockets that can hold small items such as gloves and pens.
- e. Wash hands often.
- f. Cover hair as part of a quality and safety measures.

Question 5

Not yet answered

Points out of 1.00

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Water activity, the pH of cheese during processing, as well as the temperature during aging and storing can all influence the risk of pathogen growth in cheese.

Select one:

- True
- False

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Question 1

Not yet answered

Points out of 1.00

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What is the purpose of environmental monitoring? Select all that apply.

Select one or more:

- a. To assess the effectiveness of GMPs.
- b. It acts as a food safety control to prevent cross contamination of the food.
- c. To prevent systematic problems from occurring.
- d. To keep yourself ahead in minimizing food safety threats.
- e. To identify problem spots in the form of pathogens and biofilms.

Question 2

Not yet answered

Points out of 1.00

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Corrective action for which zone requires ' test and hold ' procedures if a positive is found?

Select one:

- a. Zone 1
- b. Zone 2
- c. Zone 3
- d. Zone 4

Question 3

Not yet answered

Points out of 1.00

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The reliability of the results of finished product testing varies by cheese type, but it can help determine if controls are working to keep cheese free of pathogens.

Select one:

- True
- False