

ABSTRACT

ARNOLD, NICOLE LEANNE. Assessment of risk communication and food safety messages associated with high-risk foods. (Under the direction of Dr. Benjamin Chapman.)

Food safety education and risk communication are both used as mechanisms to provide consumers with messages to subsequently reduce the likelihood of foodborne illness. Food safety education encompasses delivering instructional content relative to mitigating the risks associated with food. Though plenty of food safety education initiatives exist, not all are effective at achieving the intended result of lessening the possibility of foodborne illness. Risk communication can be used as a way of exchanging information about food risks to consumers in order to aid them in making informed decisions. While there are currently many ways in which risk communication is instilled at retail and within foodservice, more can be done to provide consumers the appropriate risk information needed for them to make informed decisions. The purpose of this thesis was to develop studies to fill in the gaps in food safety education and risk communication pertaining to the information that consumers receive.

A collection of self-reported information about food safety communicators and their educational efforts was gathered through online questionnaires and phone calls. It was found that many gaps exist in the food safety programs that currently provide information to consumers. The review of food safety messages disclosed that while many food safety educators do target specific populations, there is a disproportion of information disseminated between certain populations. Multiple channels in which food safety information is delivered are also being underutilized. A meta-evaluation revealed that numerous food safety communicators do not measure the impacts of their programs and those that do, often do so incorrectly.

An assessment of self-reported knowledge and risk communication practices associated with undercooked oysters was administered through in-person interviews and telephone calls with foodservice personnel. This study revealed that restaurant personnel at establishments serving raw and steamed oysters are not adequate risk communicators. There were inconsistencies in how restaurant personnel described oyster doneness and inaccurate information was often provided about determining oyster doneness. Restaurant personnel also shared incorrect information about the potential for foodborne pathogens in oysters that may have been undercooked. They also poorly understand food safety information regarding undercooked oysters as the majority of those interviewed could not name foodborne pathogens associated with undercooked oysters.

A third study consisted of an assessment of the prevalence of mechanical tenderization and enhancement of beef being conducted at independent meat retailers throughout North Carolina, where food safety practices of the independent retailers were also evaluated through in-person self-reported interviews. Twenty-five independent meat retailers in an urban center in North Carolina were found to be mechanically tenderizing, vacuum tumbling beef with added marinade, or marinating or brining already mechanically tenderized beef in Wake, Durham, and Orange counties. Many of these independent meat retailers were found to be tenderizing or enhancing their beef products in ways that fall outside of the new USDA FSIS labeling rule for blade and needle tenderized beef products, highlighting the need for additional interventions for reducing risks.

The final study determined if Shiga-toxin producing *Escherichia Coli* (STEC) would either grow, persist, or die off over the span of a 6 days in different types of marinades and brines used in vacuum tumbling beef. STECs were recovered after the 5 to 6 day period in all

samples of inoculated marinade and brine. Educational materials must emphasize the importance of good food safety practices when using marinade and brine such as using at full strength, not reusing spent marinade or brine (without an antimicrobial treatment) and implementing effective cleaning and sanitation of equipment.

This research can be used to make recommendations for better food safety education and risk communication practices for consumer populations. These studies can also be used as a basis to create educational interventions for personnel working with high-risk food products.

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Assessment of Risk Communication and Food Safety Messages Associated with High-Risk
Foods

by
Nicole Leanne Arnold

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APPROVED BY:

Dr. Benjamin Chapman
Committee Chair

Dr. Dana Hanson

Dr. Andrew Binder

Dr. Jacklyn Bruce

Dr. Renee Boyer

DEDICATION

To my Mom and Dad – for this thesis would not be possible without your endless love, encouragement, and sacrifice. I will forever be thankful for your guidance and friendship.

BIOGRAPHY

Nicole Arnold was born in Greenville, North Carolina but was raised in the Raleigh area. When signing up for elective classes at Wakefield High School, her father suggested that Horticulture might be “fun.” Little did she know that she would be one of few freshmen to get accepted into a class of such high demand. Because she got to hang out with the older cool kids, Nicole continued to take every Horticulture and Natural Resources course that was offered and spent many-a-day frolicking in the greenhouse. Through these courses she became interested in biotechnology and the ability to genetically modify crops for increased yield. This led to her decision to study the science of food at North Carolina State University.

As an undergraduate, Nicole struggled through her introductory courses until she received an offer to work in the Entrepreneurial Business Laboratory where she tested food products for small businesses and entrepreneurs. She also began performing safety and quality testing for milk and ice cream products for NC State University’s Howling Cow dairy. The hands-on experiences helped Nicole to connect the dots and discover her love for food safety. She graduated from North Carolina State University in 2014 with a BS in Food Science – Technology with a minor in Agricultural Business Management. After being encouraged by her mentors whom she worked with in the labs, she continued her graduate work at NC State for her master’s in Food Science with a minor in Agricultural and Extension Education.

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INTRODUCTION

There are an estimated 48 million foodborne illnesses in the United States (U.S.) annually; of these an estimated 125,000 are hospitalized and 3,000 die (1). The costs associated with foodborne illness are estimated at \$77.7 billion, annually (4). As the epidemiology of foodborne illness evolves, old solutions must be revisited and made current to reduce this burden (1). Providing consumers with effective messages continues to be a fundamental approach to reducing foodborne illness (5). Consumers should be provided with the best available science to enable them to take measures to reduce risks.

Food safety education encompasses providing instructional content relative to mitigating the risks associated with food. Food safety information is often targeted at consumers, or those who purchase food or services related to food for personal usage. While consumers have access to a plethora of food safety information through countless sources and platforms, little work has been done to aggregate the vast amount of information about food safety intended for consumers as a whole.

Risk communication can be used as a way of exchanging information about food risks to consumers in order to aid them in making informed decisions. At retail, risk information is often communicated through food labels that appear on the packaging of products. At restaurants, establishments are required to present risk information on menus. As consumers often do not know about the heightened risk of consuming certain foods, it is crucial that these messages are present and accessible. In addition to written consumer advisory warnings, retail and restaurant personnel can also serve as risk communicators.

Restaurant personnel's food safety knowledge and practices regarding high-risk products must first be assessed before making recommendations for a how to further improve risk communication at retail and in foodservice.

The CDC List of Selected Multistate Foodborne Outbreak Investigations reports multiple foodborne outbreaks that are attributed to unsafe sources (2). *Listeria monocytogenes* in raw milk and *Escherichia coli* (*E. coli*) O121 in flour are examples of outbreaks having occurred because of unsafe sources (2). Legislation such as state laws against the sale of raw milk, requirements for shellfish tanks, and the FDA Food Safety Modernization Act (FSMA) all work to reduce risks surrounding sources that could potentially be unsafe. Although outbreaks and legislation acknowledge unsafe sources as a leading risk factor contributing to foodborne illness, messages about unsafe sources are not present.

The purpose of this thesis was to investigate whether there is a gap in food safety messages and risk communication related to current information directed at consumers. The first of these studies, a collection of self-reported information about food safety communicators and their educational efforts, was gathered through online questionnaires and phone calls to see if there were missing food safety messages, such as safe sources (Chapter 2). This study was a joint effort between North Carolina State University and the Partnership for Food Safety Education, a non-profit organization that delivers messages and resources supporting consumers in their efforts to reduce the risk of foodborne illness. In order to improve food safety programs targeting consumers, it is important to first understand the

scope of what is currently taking place; from the individuals who supply food safety information, to the specific messages being dispensed, to the types of delivery systems, and the various targeted audiences. This data can be used to address gaps in the wide array of food safety information that consumers have access to while tailoring educational materials to distinctive demographics. Evaluation practices of current food safety education programs were also assessed. A meta-evaluation was conducted to encourage and promote the use of evaluative tools and to enable more tangible and effective ways of measuring impacts. Collectively, a landscape of identified food safety educators exclusively reaching consumer populations helps to build a more robust network of information exchange and collaboration opportunities.

An assessment of self-reported knowledge and risk communication practices associated with undercooked oysters was administered through in-person interviews and telephone calls with foodservice personnel to further investigate the gap of safe sources in restaurant settings (Chapter 3). Questions were designed to examine the knowledge and practices of personnel employed at restaurants and seafood markets serving raw and steamed oysters in North Carolina. Restaurant personnel were also asked about their risk communication practices. Combined, this data was used to understand and map the infrastructure of risk information that could potentially be given to or accessed by consumers. Next, educational interventions can be targeted towards restaurant personnel based upon the gaps in food safety knowledge pertaining to raw and steamed oysters. Additionally, steps can

be taken to promote alternative measures of risk communication to consumers within foodservice.

A third study consisted of an assessment of the prevalence of mechanical tenderization and enhancement of beef being conducted at independent meat retailers throughout North Carolina to further investigate the gap of safe sources at retail (Chapter 4). Food safety practices of the independent retailers were also evaluated through in-person self-reported interviews. Interview questions sought to identify the types of processes in which independent meat retailers mechanically tenderized and enhanced their beef products, along with the handling practices surrounding these types of products. This information will be used to develop educational interventions in which the risks associated with mechanically tenderized and enhanced beef products will be addressed to educate and advise the meat retailer managers and their staff on methods to reduce risk. General demographic information will also guide the development of targeted educational materials.

The fourth study was used to assess risk related to unsafe sources that could be present at retail (Chapter 5). Different types of marinades and brine solutions used in vacuum tumbling beef were inoculated with a STEC-8 cocktail (O111:H-, O45:H2, O103:H2, O104:H4, O121:H19, O145:NM, O26:H11, and O157:H7) to determine if Shiga-toxin producing *Escherichia Coli* (STEC) would either grow, persist, or die off over the span of a 6 days. This information will be used to inform meat retailers currently utilizing vacuum tumbling, or other non-traditional marinating methods on ways in which risks to their customers and establishments can be mitigated.

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CHAPTER 1

LITURATURE REVIEW

The Centers for Disease Control and Prevention (CDC) estimates that 48 million cases of food-related illness occur in the United States each year (32, 31). The numerous cases of foodborne illness in the United States result in an economic burden estimated at \$77.7 billion, annually (32). While some epidemiological data indicates that a substantial portion of foodborne illnesses can be attributed to improper food preparation practices in consumers' homes, the true incidence of foodborne disease is difficult to determine due to factors such as underreporting and the reliance upon estimates when concrete data is not available (30, 20, 19). The majority of information pertaining to domestic food handling practices is derived from consumer-based research studies and analysis of foodborne illness outbreaks (14). Consumer-based research studies have limitations because information being collected is generally self-reported through tools such as surveys and questionnaires (30). Epidemiological studies may also be limited by the accuracy and availability of data because it is often difficult for people to recollect exact food consumption and food handling details prior to the event of falling ill (30). Although surveillance systems are presently the most effective means of identifying sources of foodborne pathogens, they too have their flaws (19). Current surveillance systems focus on the place in which food is consumed rather than the point in which the food may be been contaminated (19).

Consumer food safety

Despite the uncertainty of the occurrence of foodborne illness occurrences stemming from the domestic kitchen, studies suggest that consumers fail to handle and prepare their food safely. Phang and Bruhn investigated consumers; preparation of hamburgers in their homes and found that 22% of 199 participants did not cook them to a safe internal temperature (29). Additionally, only 4% of participants checked endpoint temperature with a meat thermometer; the only reliable way of assessing burger doneness (29, 23) Another study observed the preparation of frozen, uncooked, breaded chicken products which have been linked to outbreaks associated with consumer mishandling (9). Only 7% of 41 participants were observed adhering to the product labeling instructions that were provided, with five participants using a meat thermometer to determine doneness of the chicken product (9). In both observational studies consumers' knowledge and self-reported practices did not correspond to observed behaviors (30, 9).

Kitchens within consumers' homes are unlike a food manufacturing setting and can therefore be accompanied with additional hazards specific to the domestic environment. Borrusso and Quinlan (2013) developed an audit tool to measure compliance with recommended sanitation, refrigeration, and storage conditions within home kitchens regarding risk factors mentioned in the literature (3). Five target behaviors regarding food safety in the home kitchen environment were identified: personal hygiene and sanitation, prevention of cross contamination, avoidance of high risk food, time/temperature abuse, and overall kitchen maintenance (3). This tool used in an additional study using visual audits

found that there was evidence of pest infestation, improper storage of foods, and a lack of hot running water in the kitchen were present among many homes in an urban environment (4). Forty-three percent of homes in the study did not comply with correct refrigeration practices, with only 4% of refrigerators having contained a thermometer (4).

Consumers use a wide variety of sources to obtain information about food safety such as news programs, Internet articles, newspapers, and friends/family (6). Due to the diverse selection of channels in which consumers may favor, food safety information must have consistent messages distributed through multiple delivery systems to ensure that all audiences are reached (6). Although there is an abundance of information readily available for consumers, there are still cases of foodborne illness that can be attributed to improper food preparation practices in consumers' homes (30). Food safety information is not always adequately disseminated and adopted by consumers (33).

The "Four Core" practices of food safety (clean, cook, chill, separate) are often used as a prominent message directed at consumers. The Partnership for Food Safety Education, a non-profit organization created to educate consumer populations about food safety, have adopted the Four Core practices as their main message (28). The CDC's Information for Consumers page encourages consumers to cook to the right temperature, wash hands and surfaces often, refrigerate promptly, and warns against cross contamination (cook, clean, chill, separate) (5). The FDA's Safe Food Handling: What You Need to Know webpage for consumers describes the Four Steps to Food Safety as clean, separate, cook, and chill (12). The USDA FSIS Food Safety Education webpage displays a graphic containing the steps

clean, separate, cook, chill and that links to the Keep Food Safe Blog (www.FoodSafety.gov) (36). The Keep Food Safe Check Your Steps webpage that can be accessed through the Keep Food Safe Blog encourages readers to visit their Clean, Separate, Cook, and Chill pages (each step has own webpage) to see the most effective ways to help keep family safe from food poisoning (35).

Foods from safe sources

The CDC names food from unsafe sources as one of the top 5 risk factors contributing to foodborne illness (8). The CDC describes the risk factor of food from unsafe sources as all foods distributed in restaurants and permitted facilities being obtained from approved sources that comply with applicable laws and regulations (8). The World Health Organization (WHO) Department of Food Safety, Zoonoses, and Foodborne Diseases Five Keys to Safer Food Manual presents five core messages for safer food; keep clean, separate raw and cooked, cook thoroughly, keep food at safe temperatures, and use safe water and raw materials (21). A paper reviewing emerging trends in foodborne illness surveillance and prevention named procuring food from unsafe sources as one of the leading factors of foodborne illness in the United States between 1993 and 1997 (24). A 2009 FDA Report on the Occurrence of Foodborne Illness Risk Factors in Selected Institutional Foodservice, Restaurant, and Retail Food Store Facility Types named food from unsafe sources as a contributing factor to foodborne illness (11).

Jones and Angulo report that studies of both sporadic and outbreak-associated illness involving diverse areas, methodologies, and pathogens suggest that restaurants are an important source of foodborne disease in the United States (1). The U.S. Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report revealed that from 1998 to 2002, almost three fifths of foodborne illness outbreaks were thought to have originated at restaurants or delicatessens (22). In the majority of foodborne outbreaks during 1998 to 2002, food was eaten outside of the home (22). Restaurants were the most commonly reported place where food was consumed (22). Restaurants served more than 70 billion meals in the United States in 2005 alone (25). Nearly 50% of all the money spent on the food in the United States is spent in a restaurant setting (25).

Risk communication and message development

Risk is defined by the World Health Organization (WHO) as related to food safety as a function of the probability of an adverse effect and the magnitude of that effect, consequential to a hazard(s) in food (10). Risk analysis is a process consisting of three components: risk assessment, risk management and risk communication (10). Risk assessment is the scientific evaluation of known or potential adverse health effects resulting from human exposure to foodborne hazards which includes hazard identification, hazard characterization, exposure assessment, and risk characterization (10). Risk management is the process of weighing policy alternatives to accept, minimize or reduce assessed risks and to select and implement appropriate option (10). Risk communication is an interactive

process of exchange of information and opinion on risk among risk assessors, risk managers, and other interested parties (10). Effective risk communication is essential in limiting morbidity and mortality caused by communicable diseases, in addition to minimizing the damage that these diseases can cause to national economies and public health infrastructure (21). For risk under personal control, successful communication can help people to identify those risks that are large enough to warrant their time and attention (27). Better understanding of risk does not guarantee changes in behavior as those rely on how someone perceives benefits and risks (27).

Food labels can aid consumers in decision making when choosing to purchase food products. Research shows that most consumers have difficulty understanding information on food labels used in the United States and Canada (34). Labels can cause confusion due to misleading names given to foods such as a product marketed as a “fruit beverage” that contains less than 20% actual fruit juice or no actual fruit juice at all (34). Whereas drug adverse effects must be disclosed in advertisements, health claims on packages may ignore the presence of potentially unhealthful aspects (26). The types of food labels used in many countries fail to give consumers the information they require in a user-friendly format (34). An ineffective labeling system can be misleading, deceptive, or represent a lost opportunity to improve public health (18).

In May 2016, the U.S. Food and Drug Administration finalized a Nutrition Facts panel for packaged foods to reflect new scientific information (13). The updates are based on new dietary recommendations, survey data, and consensus reports (7). Changes to the design

include a larger type size for the designation of “Calories,” “servings per container,” and “Serving size” (13). The number of calories and the “Serving size” declaration will also be bolded (13). Updates to serving sizes will also do a better job of reflecting what people actually eat rather than what they “should” eat (7).

It is still up in the air if the labeling of food even makes a measurable difference in dietary behavior (38). Several articles raise the issue of empowerment: consumers should be empowered to use food labels, to make informed decisions, to take control over their health behaviors, and therefore their health status (38). But it is still not clear whether food labels work in this way or if they serve as a means of deliver a subliminal message that does not ultimately matter (38).

A review of European research on consumer response to nutrition labels stated that overall, the studies reviewed give only limited insight to label usage (15). Demographic information for self-reported label usage suggested that women, older consumers, more educated consumers, and those of higher social strata were more likely to use labels although these results are difficult to compare across the various studies (15). Self-reported use is most likely heavily over reported and hypothetical use need not have any relationship to actual use (15). There are practically no studies in regards to actual use (15). Communication strategies need to take into consideration the wide range of perception of risk that exist among the general public (17). Factors such as values, attitudes, knowledge, perceived control and barriers, social norms and socio-demographic may influence the usage of food labels (17).

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CHAPTER 2

An Environmental Scan of Food Safety Educational Initiatives Targeted at Consumers in the United States

INTRODUCTION

As newly recognized pathogens emerge and well-recognized pathogens increase in prevalence or association with new food vehicles, there is a need to modernize food safety educational efforts to ensure that messages are intended to reduce the risk of the most prevalent and/or serious causes of foodborne illness (1, 12). The goal of food safety message development and delivery is to reduce risky practices that may result in foodborne illness. The International Food Information Council (IFIC) Foundation conducts an annual Food and Health Survey where yearly responses continue to exemplify gaps in consumers' self reported knowledge and implementation of food safety behaviors (4). Food safety communicators must take responsibility in addressing gaps in consumers' knowledge and practices related to food safety. In the US it is not clear who delivers food safety programs to consumers and what their messages are. There also may be overlapping and/or absent themes from the food safety education efforts.

Food safety educators provide instructional content relative to mitigating the risks associated with food. Messages incorporated into food safety educational efforts may be intended specifically for consumer populations. Educators play an important role in ensuring that science based food safety information is presented in a manner that meets the needs of

the consumer. The Partnership for Food Safety Education, a non-profit organization created to educate consumer populations about food safety, was formed in 1997 as a response to an independent panel report, *Putting the Food Handling Issue on the Table: The Pressing Need for Food Safety Education (13)*. The panel report called for a public-private partnership to educate the public about safe food handling and preparation (13). The Partnership for Food Safety Education expressed interest in collecting data pertaining to the current population of food safety educators and their programs to determine if gaps were present in the messages being delivered to consumers.

Food safety educators may be in academia, government, public health, non-profit organizations, and retail, and therefore may have dissimilar opinions about what outcomes should be prioritized within food safety. The CDC identifies five contributing factors to foodborne illness, but an industry driven effort has explicitly left safe sources out of the messages. The absence of messages for safe sources results in a gap between health agencies and other organizations such as the Partnership for Food Safety Education, USDA, and FDA. Because the majority of microbial foodborne illnesses are thought to be preventable if food safety principles are understood and practiced from farm to fork, it is necessary for food safety education to also follow this continuum amongst all partners (8).

The goal of this exploratory research was to conduct an investigation of food safety educators targeting consumer populations to evaluate whether there are gaps in messages regarding safe sources. Qualitative and quantitative data outlining food safety message themes, the channels in which messages are delivered, and whom messages are delivered to

was investigated. This research also examined the prevalence and knowledge of food safety programs' evaluation methodologies. Although many agencies, organizations, and educational outlets provide the public with food safety messages, there has not to date been a systematic collection of information on who is providing food safety messages and to what audiences. This information is a necessary step towards development of a needs assessment to better describe the current population of food safety educators, their programs' messages, and to whom the messages are designed for.

MATERIALS AND METHODS

Survey instrument development. An online questionnaire (Appendix A) was chosen for convenient distribution amongst an unknown, yet potentially vast population of food safety educators throughout the United States. Using a mixed-methods approach, questions were built as a means of collecting both qualitative and quantitative data. Quantitative data collection was used to investigate prevalence of activities, messages and focus area; personal narratives can be used to enrich the quantitative results. Combined together, both types of data can produce more complete knowledge that can then be used to inform theory and practice (9).

Questions were entered into an online survey collection service, SurveyMonkey. An introduction was presented to participants upon opening the survey. The introduction described and clarified criterion for inclusion of participants. The introduction was also used to illustrate what the survey participant's responses were contributing to so that they would

feel connected to the research being conducted and therefore be more willing to participate. Additionally, information about a \$250 incentive was mentioned in the introduction. In order to encourage survey participants to complete the entire survey, only participants that fully completed the survey would be entered into a drawing for the incentive. After the introduction, survey participants were first asked for their name and contact information in order to exclude duplicate submissions and to reach them for the distribution of the incentive. Participants were asked if they would prefer to participate in the questionnaire by telephone in order to accommodate individuals that may be dissuaded from taking the survey via the online tool. To again ensure that participants met inclusion criterion, survey participants were asked directly if they fit the criteria as described in the introduction. Questions were developed to describe the participant's organization, main messages, program platforms, target audiences, and delivery channels. Questions were also created to gather information about if programs are evaluated and if so, how impacts are measured. Some questions allowed survey participants to only select a single answer choice; other questions allowed the selection of multiple choices to accommodate all possible answers. While some questions contained closed answer choices, other questions permitted survey participants to respond with open-ended answers, allowing participants to offer more detailed information specific to their own food safety programs. Skip logic, or conditional branching, was also employed to allow for further probing on specific answers. This feature changes what question a respondent sees next based upon how they answered the previous question, adapting the survey to better fit their particular circumstances. Participants were able to fill out

information for up to five food safety education programs in order to provide more specific details and to account for potential differences in messages and target audiences. While some organizations communicate one primary message, other organizations may have multiple messages that are audience specific. At the end of the survey, participants were asked if they could provide information for other individuals that would fit the inclusion criterion so that the survey could be further distributed.

Participant selection. The criterion for inclusion of participants in the study was that the survey participant must have educated consumers (individually or in combination with other audiences) about food safety. Consumers were defined as “individuals who purchase food for personal consumption and use.” Using a broader definition allowed for a greater number of food safety educators to feel qualified to provide information, thereby increasing the survey’s reach. Survey responses that did not meet the selection criterion were excluded.

Survey distribution. The survey was initially distributed electronically to the Partnership for Food Safety Education BAC Fighter listserv, a subpopulation of food safety professionals, consisting of approximately 11,700 individuals who identify themselves as “anyone who cares about ending illness and death from foodborne infection” (5). BAC Fighters may be dietitians, nutritionists, parents, caregivers, nurses, public health officials, health educators, and food retailers (5). BAC Fighters are invited to join knowledge exchange conference calls and have access to downloadable food safety materials. Additional survey participants were selected by identification through Internet searches expanded through a snowball sampling process. Snowball sampling is a type of chain referral sampling;

in this project participants were asked if they had colleagues who also provide consumer-focused food safety programming who may not have been in the initial sample. The survey was distributed in June 2014. Participants were asked to complete all answers by August 1, 2014. A second round of distribution occurred between October 16, 2014 and October 31, 2014 to allow for responses by groups or individuals who may have been missed during initial promotion.

Rationale of data collection methods. Snowball, or chain-referral sampling, is a method that has been widely used in qualitative sociological research (2). It is a type of non-probability sampling that is often used to reach hidden populations. Because food safety educators targeting consumers make up a small portion of the greater population and are dispersed among various sectors, they may be difficult to locate.

A similar study questioning school nurses and health educators about their roles, responsibilities, and major challenges in a classroom environment used purposeful snowball sampling as a means of recruitment (10). Due to the lack of research and very specific population being investigated (school nurses that serve as health educators within a school setting in Queensland, Australia) snowball sampling allowed for participants meeting the specified qualifications to be identified (10). Once located, each participant was invited to partake in an interview (10). At the conclusion of each interview, the participant was asked if they would be willing to contact other potential participants that fit the criteria (10).

Data analysis. Questions with closed answer choices were analyzed using the Question Summaries function in SurveyMonkey. The Question Summaries function provides

a qualitative overview for close-ended questions. Inductive thematic analysis was used to analyze patterns in open-ended questions. Inductive thematic analysis was applied instead of using the text analysis function in SurveyMonkey to minimize error in selecting for sequential words and phrases that could disregard overall reoccurring themes. Responses that did not provide explicit answers pertaining to the question being asked were excluded. Sample comparison tests were not used; data is reported in frequencies.

RESULTS

Following distribution, 397 surveys were completed highlighting 469 different food safety education activities. Survey participants represented both public and private sectors. Of the responses 35% of participants best described their organization as academia, 12% as federal government, 3% as food retail, 3% as industry trade groups, 12% as non-profits, 21% as public health, and 13% as the school system (kindergarten through 12th grade) (Table 1). The remaining 2% identified their organization as “other” (Table 1).

Program content. When asked what main messages were used in their organization’s food safety education programs, a textual analysis indicated that the major themes from participants’ responses were Fight BAC/4 core, safe sources, hygiene/sanitation, specific populations, Safe food handling/preparation, temporary events, containment/exclusion, non biological hazards, recalls/outbreaks, training the trainer, and non food safety topics (Table 2).

Participants were asked what food safety-based program platforms their organization used to assist in educating consumers. Thirty percent used Be Food Safe, 23% used Cook It Safe, 68% used Fight BAC, and 30% used Food Safe Families. Twenty percent used none of these, while 21% used “other” program platforms.

Target audiences. Survey participants were asked whom their programming/ outreach activities were designed to reach. Forty-one percent of programs were targeted to adults with children at home or primary meal preparers, 22% to adults without children, 45% to children and students kindergarten through 12th grade (K-12), 31% to the elderly (sixty years old and above), 13% to ethnicity based population, 32% low income populations, 36% to a mixed community of adults and kids, 20% to other food safety educators, 27% to people who are buying food, and 25% to pregnant women (Table 3). Thirty-one percent of programs were designed to reach “other” target audiences (Table 3).

Annual reach. When asked about the approximate number of individuals the educator(s) reach (interacted with) annually, 30% responded with 1,000+ people, 27% 101-500 people, 19% 50-100 people, 14% 501-1,000 people, and 10% less than 50 people.

Program channels. When asked about the types of channels programs were delivered through, 90% were delivered through in-person channels, 36% through online channels, 7% by radio, and 5% by television. Twenty-one percent of programs were delivered through “other” channels (Table 4).

Measuring impacts. When asked if their organization measured impacts of the outreach program, 10% of participants said they “did not know,” 38% said “no”, and 52%

said yes (Table 5). Those who answered “yes” were then asked how these impacts were measured. Participants responded with answers such as “analytics,” “evaluation,” “form,” “grade,” “pre test,” “post test,” “questionnaires,” “quiz,” “behavior change,” “surveillance,” “surveys,” “tests,” and “webNEERS.”

BAC fighters. Of the 397 survey participants, 26% identified themselves or their affiliated organization as being registered online as a BAC Fighter, whereas 24% said they were not, and 50% said they did not know.

DISCUSSION

The results from this study highlight multiple noteworthy gaps pertaining to the current food safety information being provided to consumers. These gaps should be addressed to improve the collective effort of food safety education among all sectors.

Participation within sectors. This is the first study to collate a database of food safety educators. Not knowing the current population of food safety educators makes collaboration difficult. While all sectors actively participate in consumer food safety education, survey participation from food retail and industry trade group representatives was minimal. Together, these two groups made up approximately 6% of the total survey population of 397. Although consumers may not be a leading target audience for these groups, it is still imperative that there is communication between the two. Contamination of food can occur at any point from farm-to-fork and therefore must be attended to by all parties regardless of their stage in production, processing, or consumption.

Main messages. Messages associated with purchasing food from safe sources are missing. Only 4% of survey respondents mentioned a message pertaining to safe sources. Purchasing food from unsafe sources can potentially increase the risk of foodborne illness as this factor has been identified as one of the most common food handling problems by consumers (3, 6). Though consumers serve as the final means for ensuring that food they will consume is safe, this is not always the case for foods, such as produce, that are not intended to be cooked. A paper reviewing emerging trends in foodborne illness surveillance and prevention named procuring food from unsafe sources as one of the leading factors of foodborne illness in the United States between 1993 and 1997 (1). Over time, foods linked to unsafe sources have continued to be a prominent theme in foodborne outbreaks, however this food safety risk factor does not always receive as much attention as others.

Children as target audience. Forty-five percent of food safety programs mentioned in this survey specifically targeted children. Food safety education programs tailored towards children are essential; however, targeting this population has its limitations. Children are typically not the primary meal preparers within the home. Habitually other individuals will make choices regarding food for them. Additional targeting of primary meal preparers may be more advantageous when allocating resources for program initiatives.

Underserved populations. With 25% of consumer food safety education programs targeting pregnant women, 32% low-income populations, 31% elderly, 41% adults with children at home or primary meal preparers, and 45% children and students, food safety educators are adequately supplying susceptible populations with information. However, less

than 15% of these outreach programs target ethnicity-based populations. It is necessary to implement programs for specific audiences because targeting a segment of a population, and understanding their behaviors, attitudes, and perceptions can lead to more effective communication of food safety messages (8). Culturally unique food handling behaviors exist within minority racial-ethnic populations and should be addressed through educational materials specifically catering to those practices (7).

Measuring impacts. With only about half (52%) of food safety educators measuring the impacts of their food safety programs, more can be done to understand the overall effect programs are having on consumers. If educators are not measuring and evaluating potential changes in consumer knowledge and behavior, then there are no concrete means of determining whether a program is accomplishing a desired outcome. Moreover, educators themselves poorly understand how to effectively evaluate their programs and measure impacts. Respondents reported using characteristics such as the number of participants attending a program and the number of resources distributed as means of evaluation. These factors give insight to qualitative traits of program reach, but do not provide any information as to whether a consumer attending the program or receiving materials gained knowledge or changed their behavior due to the program itself.

Expansion of program channels. Although 90% of food safety education programs recorded from this survey are being delivered through in-person channels, there are still opportunities to expand into other channels, as multiple delivery systems may be necessary to effectively convey food safety messages (4). Social media was not used as frequently as

some of the other delivery systems, however it has becoming an emerging channel for delivering information. This way of engaging with consumers has the potential of engaging a larger population in a short amount of time. A study that evaluated the use of social media for food safety education indicated that the use of social media for food safety education can lead to behavior changes that reduce the likelihood of contracting foodborne illness (11). Results from the study indicated that a Facebook intervention lead to improvements in food safety attitudes, practices, and knowledge (11).

Consumers also trust some sources of food safety information more than others. Government agencies/officials, health professionals/associations, and television news programs as most trusted and blogs or social networking sites as being the least trusted (4). According to the IFIC Foundation, consumers use television news programs, Internet articles, newspapers, and friends/family the most frequently for information about food safety (4). The most trusted sources of information are government agencies/officials, health professionals, health associations, and television news programs, although advice of physicians and mainstream media are more likely to prompt changes in consumers' food safety behaviors (4).

Limitations. Data may reflect the large number of BAC Fighters that received the email blasts through the Partnership for Food Safety Education BAC Fighter listserv and the percentage of survey participants using the Fight BAC program platform within their food safety programs. Responses may be catered toward main themes associated with the

Partnership for Food Safety Education such as the four core practices for reducing the likelihood of foodborne illness and targeting food safety initiatives towards children.

The snowball sampling strategy used within this study could potentially lead to overlapping data among like programs. As educators were analyzed rather than the programs themselves, participants could be delivering the same programs. Overlapping programs would result in the program being accounted for more than once and could therefore skew some of the summary statistics.

Table 1: Sectors of Survey Participants' Affiliated Organizations

Sector	Frequency (%)
	n=397
Academia	139 (35%)
Federal government	49 (12%)
Food retail	12 (3%)
Industry trade groups	10 (3%)
Nonprofits	46 (12%)
Other	6 (2%)
Public health	85 (21%)
School system (K-12)	50 (13%)

Table 2: Main Messages of Survey Participants' Food Safety Education Programs

Main Message	Frequency (%)
	n=645
Fight BAC/4 core	143 (22%)
Generally speaking	126 (20%)
Cook, clean, chill	8 (1%)
Cook, clean, separate	2 (0%)
Clean, chill, separate	1 (0%)
Cook, separate	2 (0%)
Cook, clean	3 (1%)
Clean, chill	1 (0%)
Safe sources	26 (4%)
Generally speaking	22 (3%)
GAPs	2 (0%)
High risk foods	2 (0%)
Hygiene/sanitation	138 (21%)
Generally speaking	103 (16%)
Handwashing	35 (5%)
Specific populations	60 (9%)
High risk populations	31 (5%)
Low income individuals	4 (1%)

Table 2: Continued

Hispanic populations	1 (0%)
Moms/pregnant women	2 (0%)
Seniors/elderly	11 (2%)
Children	6 (1%)
Students (grades 6-8)	5 (1%)
Safe food handling/preparation	213 (33%)
Generally speaking	47 (7%)
Cross contamination	12 (2%)
Proper storage	71 (11%)
Temperature/cooking/thawing	46 (7%)
Preservation	17 (3%)
Transport/receiving	5 (1%)
Packaging	1 (0%)
Reheating	4 (1%)
Thermometer usage	6 (1%)
Labels	4 (1%)
Temporary events	10 (2%)
Generally speaking	4 (1%)
Volunteers	4 (1%)
Summer grilling	2 (0%)

Table 2: Continued

Containment/exclusion	5 (1%)
Generally speaking	1 (0%)
Sick/hurt individuals	3 (1%)
Norovirus/vomiting	1 (0%)
Non biological hazards	6 (1%)
Contaminants/adulterants	3 (1%)
Chemicals	1 (0%)
Pests	1 (0%)
Allergens	1 (0%)
Recalls/outbreaks	28 (4%)
Generally speaking	1 (0%)
Reporting illness	18 (3%)
Foodborne pathogens/illnesses	9 (1%)
Non food safety	16 (3%)
Nutrition	10 (2%)
Product dating	4 (1%)
Sustainability	1 (0%)
Buying local	1 (0%)

Table 3: Target Audiences for Survey Participants' Food Safety Education Programs

Target Audience	Frequency (%)
	n=469
Adults with children at home/primary meal preparers	175 (41%)
Adults without children	105 (22%)
Children/students (K-12)	213 (45%)
Elderly (60+ years old)	147 (31%)
Ethnicity-based populations	42 (13%)
Low income populations	153 (32%)
Mixed community of adults and kids	168 (36%)
Other	147 (31%)
Other food safety educators	93 (20%)
People buying food	125 (27%)
Pregnant women	119 (25%)

Table 4: Channels of Delivery for Survey Participants' Food Safety Education Programs

Channel	Frequency (%)
	n=469
In-person	421 (90%)
Online	167 (36%)
Other	100 (21%)
Radio	36 (7%)
Television	24 (5%)

Table 5: Survey Participants' Response to if Impacts of Food Safety Education Programs are Evaluated

Response	Frequency (%)
	n=469
I don't know	48 (10%)
No	176 (38%)
Yes	245 (52%)

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CHAPTER 3

**Knowledge and Risk Communication for Undercooked Oyster Preparation in
Restaurants**

INTRODUCTION

Consumers are faced with choices at each meal, whether in the home or food prepared outside the home. As the science around food safety has developed, so has consumer choice. In the past three decades there has been a shift to risk-based decision making within the risk analysis framework (5). Included within that framework are risk assessment, risk management, and risk communication. Risk analysis is the systematic review of prevalence, consequence, and consumption rates (5). Risk management are actions employed to reduce the change of foodborne illnesses (5). Risk communication conveys the risks surrounding certain foods so that consumers are able to make more educated decisions about what they and their loved ones consume (5). Consumers are provided with many risk reduction messages in food service as it relates to choice. Restaurants serving oysters often communicate risks associated with consuming raw shellfish, although there may be a lack of communication about the risks of consuming steamed oysters. Risks in the U.S. are required to be communicated through consumer advisories located within the menu, by signs posted around the restaurant, and/or through verbal reminders from restaurant personnel.

Bivalve mollusks, or shellfish (clams, oysters, mussels), provide a specific food safety risk that stems from a unique ability to filter the water. Water in which bivalves reside

can become polluted with human sewage. Fecal matter containing virus gets bioaccumulated in the water and when consumed by shellfish can remain there. Individuals become infected when raw or lightly steamed oysters containing virus are eaten. Although there are many foodborne pathogens that can contaminate oysters, *Vibrio spp.* and norovirus are the most prevalent among foodborne pathogens found in raw and undercooked oysters.

Between 1969 and 2000 there were 18 outbreaks worldwide associated with norovirus in both clams and oysters, which affected 5,923 individuals (10). Between this time period there were also five outbreaks associated with *Vibrio parahaemolyticus*, four associated with *Virbrio cholera*, one associated with *Vibrio vulnificus*, one associated with *Vibrio mimicus*, and one associated with *Vibrio hollisae* in bivalve mollusks (10). Another study, specific to the United States, reported that there were 50 cases of *Vibrio spp.* associated with mollusks and seven cases of norovirus associated with mollusks between 1973 and 2006 (7).

A public health report also discusses other North Carolina outbreaks associated with norovirus in steamed oysters in 1993 (1). Steamed oysters were served at two church suppers. In the two North Carolina church kitchens, oysters had been steamed for at least 12 minutes and were considered ready for consumption when some shells had opened (8). Stool samples taken from three ill individuals at the first church supper were positive for norovirus (8). Only 10 church members (21%) surveyed after the dinners were aware that cooked oysters could be a reservoir for norovirus (8).

To reduce risks associated with oyster consumption, FDA recommends they be cooked to an internal temperature of 145⁰F for 15 seconds to ensure an 8-log reduction of *Vibrio spp.* that could be present (6). However, studies have indicated that shellfish must be cooked using greater time/temperatures in order to inactivate norovirus (2, 3, 4). These disparate time/temperature combinations must be taken into consideration when preparing steamed oysters. If oysters are steamed, while they may be free of *Vibrio spp.*, norovirus may not have been inactivated.

In December 2009, over 400 patrons of a North Carolina restaurant acquired norovirus from lightly steamed oysters (1). Many individuals reported experiencing gastrointestinal symptoms after dining at the same establishment (1). After a multi-agency investigation took place, it was concluded that the outbreak resonated from lightly steamed oysters (1). Of those patrons experiencing symptoms, most (92.2%) consumers had ingested oysters, with 82.4% of patrons having ate steamed oysters (1). Norovirus RNA was detected in three of five stool specimens obtained from ill patrons (1). It was determined that oysters had been steamed rare (2 min), medium (4 min), or well done (6 min) based on the consumers' requests (1).

Restaurant employees may not communicate food safety risks regarding undercooked food products, specifically oysters, to consumers. The absence of consumer advisory warnings (both written and verbal) regarding undercooked oysters put customers at greater risk of foodborne illnesses, especially those that may have compromised immune systems. It is necessary to determine the level of food safety knowledge and risk communication within

restaurants to ensure that customers are provided with enough information to make educated and informed decisions about consuming raw and undercooked oysters.

The FDA 2009 Model Food Code states that if shellfish are served raw, undercooked, or not otherwise processed to eliminate pathogens, the permit holder shall inform consumers of the significantly increased risk of consuming such foods (6). This is done by way of both a disclosure and a reminder using brochures, deli case or menu advisories, label statements, table tents, placards, or other effective written means (6). A disclosure must include a description of the food or identification of the food with an asterisk to a footnote that states that the items are served raw or undercooked (6). The reminder must include asterisking the food requiring disclosure to a footnote that states one of the following three options: 1) Regarding the safety of these items, written information is available upon request, 2) Consuming undercooked meats, poultry, seafood, shellfish, or eggs may increase your risk of foodborne illness, or 3) Consuming undercooked meats, poultry, seafood, shellfish, or eggs may increase your risk of foodborne illness, especially if you have certain medical conditions (6).

Compliance with FDA 2009 Model Food Code can still lead to gaps in communicating the risk of consuming raw or undercooked shellfish to patrons. While consumers may be aware of risks associated with raw oysters, they may perceive steamed oysters as being thoroughly and safely cooked and therefore free of foodborne pathogens.

The purpose of this study was to test the hypothesis that restaurants serving raw and/or steamed oysters do not implement food safety and risk communication practices that

can aid in reducing risks associated with undercooked oysters. It is also hypothesized that individuals employed at restaurants serving raw and/or steamed oysters are not well informed about risks associated with undercooked oysters. Hypotheses were tested by surveying restaurant personnel at restaurants serving raw and/or steamed oysters in an urban center in North Carolina. Results from this study can help to address gaps in the current state of food safety and risk communication at restaurants serving undercooked oysters. In turn, educational interventions for both restaurant personnel and consumers can be created depending on what risk information is currently known and being provided to patrons.

MATERIALS AND METHODS

A semi-structured interview (Appendix B) was created to assess food safety knowledge of employees and risk communication practices of businesses related to undercooked oyster preparation in a restaurant setting. Semi-structured interviews were chosen as the survey tool to allow researchers to ask probing questions to elicit additional opinions and explanations of the topics (9). Mixed methods were used to collect information through questions that allowed participants to describe their establishment's food safety and risk communication practices. Questions were designed to collect both qualitative and quantitative data to incorporate and address the variety of methods in which restaurants operate. Additionally, some questions were created with the intent of gauging restaurant personnel knowledge and perceptions of risks associated with undercooked oysters. Content analysis was performed on open-ended questions to determine major themes and important

aspects of food safety and risk communication practices, specifically, gaps in knowledge and perception of risks associated with undercooked oysters.

A list of inspected facilities was obtained from local health departments in Wake, Durham, and Orange counties in North Carolina. Each list contained all permitted facilities (both food and non-food) inspected by the local health department. Searches performed using the Google search engine (www.google.com) were used to identify restaurants serving oysters. Restaurant names and addresses were used as search terms. Online materials such as restaurant websites, menus, and social media were first used to evaluate whether raw and/or steamed oysters were served. If this characteristic could not be determined through Google searches alone, the restaurant in question was contacted via telephone. Searches were conducted between June 2014 and June 2016.

Selection criteria. The criterion for restaurant selection was that the establishment must serve raw and/or steamed oysters. Raw and/or steamed oysters did not specifically have to be listed on the menu; they could be ordered upon request. All restaurants found serving raw and/or steamed oysters in Wake, Durham, and Orange counties chose to participate in the study. Human subjects approval was received from the Institutional Review Board.

Restaurant visits. Restaurants that sold raw and/or steamed oysters, and those that were in question, were visited where an in-person interview was given. Once a restaurant was confirmed as serving raw and/or steamed oysters, researchers visited each restaurant location unannounced. If a restaurant was not available for an in-person interview during the time of arrival, alternative options were given, such as an in-person meeting scheduled for another

time or a telephone interview. E-mail was used as a final attempt to engage with restaurant personnel and was only used as a means of communication when requested by the restaurant itself.

Before restaurant personnel partook in the survey, interviewers revealed that they were collecting responses on behalf of research to reduce any perceived coercion to participate. Upon restaurant arrival, the interviewers first approached restaurant personnel at the hostess stand or front desk. First, a manager or chef was requested for a brief five to ten minute survey. If these individuals were not available, other personnel such as wait staff or hostesses/greeters were requested to participate.

Pre-testing interviews. Interview questions were pre-tested with a convenience sample (n=20) of restaurants serving oysters in Wake, Durham, and Orange counties. Questions were pre-tested to confirm that the topics being asked about were not out of scope. Once information had been comprised to characterize the state of food safety and risk communication practices, some questions were removed from the original interview. Restaurant visits taking place after questions were removed implemented the modified interview script.

RESULTS

Thirty-six restaurants of the 4,014 permitted restaurants in Wake, Durham, and Orange counties were found to be selling raw and/or steamed oysters at their establishment. Twenty-three of these restaurants served both raw and steamed oysters, with twelve having

served raw oysters only and one serving steamed oysters only. Responses obtained from restaurants that shut down (permanently closed) after being surveyed, but prior to the end of data collection are reported in this study. Two restaurants included in the sample, both serving raw and steamed oysters, shut down.

Steaming Process. Restaurants that serve steamed oysters were asked to describe their steaming process. Seven individuals specifically mentioned that steamed oysters were cooked to order by the customer/ordered by varying degrees of doneness. The terms “light” and “hard” or “well” were the only degrees of doneness mentioned. When describing steamed oysters ordered to be cooked as “light,” one respondent revealed its correspondence with steaming for 30 seconds to 2 minutes, another participant said 1 to 3 minutes, and a third individual said 2 minutes (Table 1). When describing steamed oysters ordered to be cooked as “hard” or “well,” one individual said this coincided with steaming for 3 minutes, another individual said 3 to 4 minutes, and a third respondent said 3 to 5 minutes (Table 2). When describing how long oysters were typically steamed for, various responses were given; 45 seconds, no more than 2.5 minutes, 2 to 3 minutes (3 respondents), 2 to 5 minutes, 4 minutes (2 respondents), 4 to 6 minutes, 5 to 10 minutes, and 12 to 14 minutes (Table 2). Only one individual mentioned temperature (165°F) when describing their steaming process.

Restaurants had different ideas of what varying levels of doneness entailed. This remains inconsistent for the consumer when ordering at different restaurants. Oftentimes, an establishment did not ask the consumer how they wanted steamed oysters to be prepared, therefore making the risk decision for them.

Shellstock tags and labels. Restaurants serving raw and/or steamed oysters were asked how long they kept tags and labels from oyster shipments. Twenty-six establishments kept Shellstock tags and labels for the required time of at least 90 calendar days (6). One establishment kept tags and labels for 35 days. Nine establishments either did not know or did not disclose information about how long tags and labels were kept.

Keeping Shellstock tags and labels for only 35 days goes against what is required by the FDA Food Code (6). Shellstock tags and labels are used to identify shellfish in a way that if an outbreak were to occur, product could be traced back to its original sources where steps could then be taken to reduce the risk of further outbreaks. This particular restaurant would have no way of tracing back their product if shellfish tags/labels had already been discarded after 35 days.

Consumer advisory warnings. Restaurants serving raw and/or steamed oysters were asked about consumer advisory warnings for undercooked oysters. These responses did not take into consideration consumer advisory warnings located within the menu, as this is already required. Sixteen restaurant personnel mentioned hanging signs within their establishment. One individual mentioned giving personal verbal reminder when patrons ordered oysters. Twenty restaurant personnel did not know or did not disclose information about consumer advisory warnings beyond the required written consumer advisory located within menus.

While other consumer advisory warnings are not required in addition to the written consumer advisory warning with restaurant menus, having more ways of communicating

potential risks to consumers can aid them in making educated decisions. Many establishments only reported having the written consumer advisory in the menu as the role way of communicating the risk of consumer undercooked oysters to consumers. Only one individual mentioned a verbal reminder to consumers when they ordered undercooked oysters. This is of importance because though consumers seek risk information from servers, they do not always see themselves as being responsible for communicating risk to patrons.

Fully cooked. Restaurants serving steamed oysters were asked what they would tell a customer if questioned whether steamed oysters were fully cooked or not. Fully cooked was defined to them as meaning free of all foodborne pathogens. Fifteen restaurant personnel said that they would not tell a consumer that steamed oysters are fully cooked or that this depending on factors such as cook times and degrees of doneness. Nine restaurant personnel said that they would tell a consumer that steamed oysters are fully cooked and therefore free of foodborne pathogens. Cooking temperatures (160°F and 145°F) were given by three restaurant personnel and one individual stated that steamed oysters would be free of foodborne pathogens based upon the quality of harvesting waters.

Norovirus is difficult to inactivate unless under high temperatures. These temperatures could be hard to reach through light steaming and may also not be desired by the restaurant or consumers due to changes in product characteristics. However, it is imperative that consumers be provided with accurate information so that they can make educated decisions about what types of risks they are willing to take regarding their food.

Foodborne pathogens. Personnel from restaurants serving raw and/or steamed oysters were asked if they were aware of any foodborne pathogens associated with undercooked oysters. Thirty restaurant personnel said that they either did not know of any foodborne pathogens associated with undercooked oysters or they provided incorrect information. Two restaurant personnel were able to name *Vibrio*, three named norovirus, and one was able to identify both Hepatitis and norovirus.

Only having 4 of the restaurant personnel able to name foodborne pathogens associated with raw or steamed oysters is of concern as the majority of these establishments specialize in serving seafood. Consumers often order seafood, specifically mollusks, to be ordered undercooked therefore consuming a higher risk food. High risk foods (raw and steamed oysters) should be handled differently than their less risky counterparts (fried and baked oysters) because a lethality great enough to kill foodborne pathogens likely to be present is not being delivered. Restaurant personnel cannot take steps to mitigate the risks of the introduction and persistence of these pathogens if they do not first know that they exist and the characteristics in which they possess.

Reported cases of foodborne illness. Personnel from restaurants serving raw and/or steamed oysters were asked if their establishment had ever had any reported cases of foodborne illness due to raw or steamed oysters. One individual described an incident taking place approximately six years ago where there were cases [of foodborne illness] associated with steamed oysters. According to this person, tests for both employees and oysters came back negative and the investigation was inconclusive. Another individual at a different

restaurant described occasionally having customers call in sick a few days after eating at their establishment but reported that these incidences have never occurred involving more than one customer at a time and had not been linked back to a specific source.

DISCUSSION

This study demonstrates that food safety knowledge is poorly understood by restaurant personnel although they are oftentimes a source of risk information for consumers. Restaurant personnel answered survey questions in a way that demonstrated that they not only poorly understand food safety knowledge regarding raw and steamed oysters, but also may be providing consumers with incorrect information. This data provides the foundation for an educational intervention for managers, servers, and patrons as it relates to risk management practices.

Limitations. Restaurant personnel may be hesitant or unwilling to discuss their practices with unknown individuals. Due to availability as these individuals were interviewed in their place of work, personnel with different titles and responsibilities were surveyed. Different roles within the restaurants may have more or less food safety knowledge. For example, chefs are usually responsible for the preparation of food. This may require food safety training that an individual, such as a hostess, would not necessarily need.

Table 1: Terms Mentioned as Describing Degrees of Oysters Doneness for Steamed Oyster
By Restaurant Personnel

Term	Time
Light	30 seconds – 2 minutes
	1 – 3 minutes
	2 minutes
Hard/Well	3 minutes
	3 – 4 minutes
	3 – 5 minutes

Table 2: Restaurant Personnel Responses for How Long Oysters are Typically Steamed

Time	Frequency (%)
	n=11
45 seconds	1 (9%)
No more than 2.5 minutes	1 (9%)
2 – 3 minutes	3 (27%)
2 – 5 minutes	1 (9%)
4 minutes	2 (18%)
4 – 6 minutes	1 (9%)
5 – 10 minutes	1 (9%)
12 – 14 minutes	1 (9%)

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CHAPTER 4

Prevalence and Conditions of Mechanical Tenderization and Enhancement of Beef at Independent Meat Retailers in North Carolina

INTRODUCTION

Mechanical tenderization and enhancement are processes that can be performed to add value to beef products. Mechanical tenderization is used to improve palatability and tenderness of beef (1, 5). Enhancing beef by way of liquid (injecting, vacuum tumbling, etc.) can also improve sensory attributes (19). Mechanically tenderized is defined by the 2013 Food and Drug Administration (FDA) Model Food Code by manipulating meat with deep penetration by processes which may be referred to as “blade tenderizing,” “jaccarding,” “pinning,” “needling,” or using blades, pins, needles or any mechanical device (4). The 2013 FDA Model Food Code definition of mechanically tenderized specifies that mechanically tenderized does not include processes by which solutions are injected into meat (4). Injected is defined by the 2013 Model Food Code as manipulating meat to which a solution has been introduced into its interior by processes that are referred to as "injecting," “pump marinating,” or "stitch pumping” (4). The United States Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS) final rule for Descriptive Designation for Needle- or Blade-Tenderized (Mechanically Tenderized) Beef Products requires raw or partially cooked beef needle- or blade- tenderized beef products, including products injected with marinade or solution to be labeled as such (i.e. mechanically tenderized, blade tenderized, or

needle tenderized) (17). To be labeled as marinated, FSIS Food Standards and Labeling Policy Book require a to use a marinade that is a mixture in which food is either soaked, massaged, tumbled, or injected in order to improve taste, tenderness, or other sensory attributes, e.g., color or juiciness (18). For the purpose of this study, mechanical tenderization was defined to include any and all means of manipulating meat with deep penetration by processes which may be referred to as “blade tenderizing,” “jaccarding,” “pinning,” “needling,” or using blades, pins, needles or any mechanical device (4). Enhancement was defined to include any and all means of infusing beef with liquid (i.e. marinade or brine) accompanied by any and all means of manipulating meat with deep penetration. Per the definition of mechanical tenderization, the term enhancement (i.e. vacuum tumbling with marinade or brine, injecting marinade or brine, marinating or brining before or after mechanical tenderization occurs) falls into the broader category of mechanical tenderization.

Since 2000 there have been six confirmed outbreaks of *E. coli* O157:H7 in mechanically tenderized beef products (17). Additionally, in 2012, a foodborne illness outbreak attributed to *E. coli* O157:H7 in mechanically tenderized beef products occurred in Canada (2, 17). The food safety investigation for the outbreak determined that a few of the cases were likely associated with consumption of mechanically tenderized beef that had been tenderized at retail (2, 17).

Risks associated with mechanically tenderized beef products result from possible pathogen internalization by transferring potential pathogens from the exterior to the interior of beef sub-primals (10, 15). The potential for translocation of pathogens requires different

risk management steps during cooking (10). Enhanced beef can introduce pathogens by way of the liquid being incorporated into the process. Cross-contamination of sub-primals during processing may occur if liquid is reused after coming into contact with beef containing pathogens.

Equipment used to mechanically tenderize and enhance beef products can be challenging to clean and sanitize, due to the complicated construction and inability to take apart. Improper cleaning and sanitation practices can allow for pathogens to persist in niches, resulting in subsequent contaminated batches (20). For enhanced beef products, pathogens have been shown to persist in commercial marinades (11, 14).

There are numerous types of equipment used to mechanically tenderize and enhance beef products. Hand-held meat tenderizers, like the Jaccard (Table 2), can use needles or blades to cut through connective tissues (8). Cubing devices, such as the Hobart Meat Tenderizer (Table 2), uses blades to cut beef and also has the ability to knit multiple cuts firmly together, so that it will cook as one solid steak (7). Other tools, like meat mallets (Table 2), allow beef to be prepared to desired tenderness (9). Vacuum tumblers, such as the DVTS 200 Tumbler (Table 2), can be used to infuse liquid with beef (3).

Some information is known about the prevalence of mechanical tenderization of beef occurring at official manufacturing facilities in the United States. The Final Report of the Expert Elicitation on the Market Shares for Raw Meat and Poultry Products Containing Added Solutions and Mechanically Tenderized Raw Meat and Poultry estimates that there are 555 establishments that produce blade or needle tenderized beef products in the United

States (12). This report was also used to estimate that about 10.5% of total beef products sold, or about 2.6 billion pounds (total U.S. beef production estimated at 24.3 billion pounds in 2010) are mechanically tenderized (12, 17). Mechanical tenderization potentially being conducted by retailers on site is only mentioned once within the USDA FSIS labeling rule document; FSIS estimates that very few retail facilities are producing mechanically tenderized beef. No data is given as to why FSIS estimates that very few retail facilities are producing mechanically tenderized beef. To date, there have been no studies reporting the prevalence of mechanical tenderization and enhancement of beef at meat retailers, either chain or independent retailers, that are performing tenderization within the retail setting itself.

The purpose of this study was to test the hypothesis that mechanical tenderization and enhancement of beef occur on site at independent meat retailers. Prevalence of mechanical tenderization and enhancement of beef prepared at independent meat retailers was determined by surveying a convenience sample, an urban center in North Carolina. Once prevalence was determined, this study served as a way to collect further data assessing the practices of meat retailer personnel surrounding mechanically tenderized and enhanced beef products. Results from this study can be used to educate meat retailer personnel about risks associated with mechanically tenderized and enhanced beef products, specifically those pertaining to practices self-reported by meat retailer managers and staff.

MATERIALS AND METHODS

A semi-structured interview (Appendix C) was created to characterize prevalence of mechanical tenderization and enhancement of beef taking place on site at meat retailers. Semi-structured interviews were chosen as a tool to lead conversation in a standardized way, while still allowing opportunities for relevant issues to emerge (13). In-person interviews can facilitate trust between the interviewer and interviewee that can lead to more honest and reliable responses. Semi-structured interviews were also used as a way to specify processing terminology when differences in vernacular existed. Once prevalence was established, further information was collected to illustrate how mechanically tenderized and enhanced beef products were prepared. Mixed-methods were used to gather data through interview questions that pertained to both quantitative and qualitative aspects of the practices associated with mechanically tenderized and enhanced beef products. Questions were asked about equipment used to mechanically tenderize and enhance beef products because each type of equipment can produce products with different risk profiles. Because equipment used to mechanically tenderize and enhance beef may be difficult to clean and sanitize, questions were created to illustrate if this was being done correctly. Specifically, questions detailed how meat retailer personnel cleaned and sanitized equipment used to mechanically tenderize and enhance beef products, while also depicting the frequency. Some questions categorized the different cuts of beef and their thickness as these characteristics can play a role in potential pathogen penetration. Questions regarding storage parameters of beef and marinade/brine were asked to depict if meat retailer personnel were implementing risk

practices that could facilitate the survival or growth of pathogens associated with beef. Different formulations of liquid used to enhance beef can vary in ability to control pathogens, therefore questions were asked to catalogue the type of solutions being used.

A list of inspected facilities was obtained from each local health department; Wake, Durham, and Orange counties in North Carolina. Each list contained all permitted facilities (both food and non-food) inspected by the local health department. Google searches (www.google.com) were performed to determine which food establishments from the lists sold raw or partially cooked beef products in addition to what might be done in a restaurant. Meat retailer (permitted as meat markets, restaurants, or food stands) names and addresses were used as search terms. Searches were conducted from May 2015 to June 2016. Telephone calls were used as a second method to confirm the selling of raw or partially cooked beef products if this could not be determined through Google searches alone.

Selection criteria. Retailers must have 1) Been permitted as an establishment in Wake, Durham, or Orange counties; 2) Sold meat, specifically raw or partially cooked beef, to consumers at their establishment 3) Sold mechanically tenderized or enhanced beef and 4) Performed these processes at the establishment itself.

Meat retailer visits. Establishments that did sell raw or partially cooked beef products, and those that were in question, were visited where an in-person interview was given. If an establishment was thought to be selling raw or partially cooked beef, researchers visited the location unannounced. Upon arrival, the interviewers first asked for a meat counter manager or general manager. Other employees were requested for an interview if no

manager was present. If an establishment was not available for an in-person interview during the time of arrival, alternative options were given such as an in-person meeting scheduled for another time or a telephone interview.

Before a meat retailer employee partook in the survey, interviewers revealed that they were collecting responses on behalf of research to reduce any perceived coercion to participate. Because the terms mechanical tenderization and enhancement have various meanings and may not be understood by the general public, an introduction was recited before the interview to describe to meat retailer personnel in detail the processes of mechanical tenderization and enhancement. In the interview script, mechanical tenderization was described as using needles or blades to break-down and penetrate muscle fibers. Tenderization was also described as occurring when marinade or tenderizing solution is injected into muscle fibers. Examples of mechanical tenderization such as cubing, blade tenderizing, and needle tenderizing were provided for reference. Needle injection, vacuum tumbling, and marinating before mechanical tenderization were given as examples of enhancement. If a meat retailer was not mechanically tenderizing or enhancing their beef products on site, the interview did not continue with questions about the processes.

Pre-testing interviews. Interview questions were pre-tested at independent meat markets selling raw or partially cooked beef within a familiar county, inspected four times a year. Pre-testing was implemented to ensure that familiar terminology was being used for meat retailer employee understanding. Once more information was gathered to further characterize mechanical tenderization and enhancement of beef at retail, additional questions

were added to the original interview. Meat markets that had been visited for pre-testing were revisited with the modified interview script.

RESULTS

Prevalence. A total of 191 meat retailers of the 4,353 permitted establishments (both chain and independent establishments) were found to be selling raw or partially cooked beef in Wake, Durham, and Orange counties. Of the 191 meat retailers selling raw or partially cooked beef, 25 independent meat retailers were mechanically tenderizing or enhancing beef products on site: 13 in Wake County, 7 in Durham County, and 5 in Orange County. In Wake County all 13 retailers were physically tenderizing beef in some way (i.e. cubing, jaccarding, needling), while 2 of the 13 entities also vacuumed tumbled beef with added marinade and 1 marinated already tenderized beef products (Table 3). In Durham County, all 7 retailers were physically tenderizing beef in some way (Table 3). In Orange County all 5 retailers were physically tenderizing beef in some way, while 1 of the 5 entities also brined already tenderized projects (Table 3).

Equipment. The Hobart, used for cubing, was overwhelmingly the primary tool used among meat retailers for mechanical tenderization of beef products. Eighteen retailers cubed beef using a Hobart tenderizer with 2 retailers using similar models (Berkel and Procut KT8) (Table 4). Five retailers used hand-held tenderizers/jaccarding tools such as the Chef Master and SR Needle Charger models (Table 4). Two retailers used mallets for tenderization purposes while one retailer did not know or would not disclose information about the type of

equipment used for tenderization. One of the meat retailers that vacuum tumbled with added marinade disclosed that a Daniels Food Equipment DVTS 200 model is used while the other retailer did not disclose information about the equipment used to vacuum tumble their products (Table 4).

Temperature. Before tenderization, 23 of the retailers said that products were kept at 41°F or below, although one retailer kept products between 44 and 45°F. Two of the retailers did not know or would not disclose information regarding the temperatures before tenderization. After tenderization occurs, 23 of the retailers said that products were kept at 41°F or below. One meat retailer gave products to customers immediately after tenderization. One of the retailers did not know would not disclose information regarding the temperatures after tenderization.

Cleaning and sanitation. When asked how frequently equipment used to mechanically tenderize and enhance beef was cleaned and sanitized, 8 meat retailer personnel said after every use and 6 meat retailer personnel said between 1 to 2 times per day. Eleven meat retailer personnel said they did not know or did not disclose information about frequency of cleaning and sanitizing of equipment. Twenty-three meat retailer personnel mentioned some type of sanitizing or chemical step when asked about cleaning and sanitizing procedures. One retailer used only soap and water to clean equipment while one retailer did not know or did not disclose information about cleaning and sanitizing procedures.

Cuts and thickness. When asked what cuts of beef are tenderized, 17 meat retailer personnel mentioned cuts coming from the round (top round, bottom round, and eye of round

specifically mentioned), 4 coming from the loin (bottom loin, beef tips, and sirloin cap specifically mentioned), 2 coming from the chuck (chuck eye specifically mentioned), and 1 coming from the flank. Four meat retailer personnel did not know or did not disclose information about the cuts of beef being tenderized. When asked what thickness of beef is mechanically tenderized at the establishment (conservatively), 3 meat retailers used 2 to 2 ¼" thickness, 5 used 1 to 1 ¼" thickness, 8 used ¼" to ¾" thickness, and 1 used 1/8" thickness. Eight meat retailer personnel did not know or did not disclose information about thickness of the cuts of beef that were mechanically tenderized.

DISCUSSION

Risky practices among independent retailers must be addressed through educational interventions. As mechanically tenderized and enhanced beef products have been classified as higher risk than those that remain intact, meat retailers must also take steps themselves to reduce risk before the product reaches the consumer, especially as only 5 of the 25 independent meat retailers mechanically tenderize some of their beef products (independent meat retailers may mechanically tenderize their products using more than one process) in a way that will require labeling. Proper refrigeration temperatures are necessary to reduce the risk of microbiological persistence or growth if pathogens are present. One retailer reported holding beef intended for mechanical tenderization between 44 and 45°F rather than at refrigeration temperatures (40°F or below) recommended by the USDA (16). Although holding beef between 44 and 45°F is not an infraction of the Food Code, this suggests that

meat retailer personnel may not treat mechanically tenderized and enhanced beef different than intact beef (3). Multiple retailers did not know or did not disclose information about the refrigeration temperatures at which they kept beef intended for mechanical tenderization. This suggests that meat retailer personnel may not be aware of or may not be implementing good practices regarding temperature. Proper cleaning and sanitation of equipment used to tenderize is needed to prevent cross contamination between batches. One retailer only mentioned soap and water when asked about cleaning and sanitation practices. Although soap and water can be used to remove debris, this step is needed in combination with an additional step of sanitizing to reduce or eliminate potential pathogens. Some retailers reported cleaning and sanitizing after every use, while others only did so 1 to 2 times a day. Improper or infrequent cleaning and sanitation of equipment used to mechanically tenderize and enhance beef indicates that extra precaution is not taken concerning these high-risk products. Multiple retailers did not know or did not disclose information about their cleaning and sanitizing procedures or the frequency in which they cleaned and sanitized equipment. This suggests that meat retailer personnel may not be aware of or may not be implementing good practices regarding cleaning and sanitation of equipment.

Meat retailers were often found located within close proximity of other meat retailers, supplementing niche markets. Many of the meat retailers mechanically tenderizing or enhancing beef products were identified as markets serving minority races/ethnicities. This frequently resulted in language barriers between the interviewers and meat retailer personnel. Prior to this study, there was no information available if mechanical tenderizing or

enhancement of beef was being performed on site. Now that the prevalence and parameters of these processes are better defined, meat retailer managers and employees can be educated about food safety practices that could potentially reduce the risks surrounding these types of products. Educational materials must be created to address the diverse demographic profile of meat retailers. As culturally unique food handling behaviors have been found to exist within minority racial-ethnic populations in their homes, these behaviors may also enter into the retail setting (6). Therefore, educational materials must specifically cater to those practices.

Table 1: Equipment Used to Mechanically Tenderize and Enhance Beef at Meat Retailers

Mechanism	Equipment Example	Reference
Hand-held needle or blade tenderizers	Jaccard Meat Maximizer™ Meat Tenderizer - 15 Knife	http://www.jaccard.com/Meat-Maximizer-Meat-Tenderizer--15-Knife_p_9.html
Cubing devices	Hobart 403 Tenderizer	http://www.hobartcorp.com/products/food-prep/tenderizers/
Pounding devices	TEB-12 Adcraft - Meat Tenderizer, 2- sided, extra-heavy cast aluminum, 12- 3/4" O.L	http://www.jesrestaurantequipment.com/meat-tenderizer-2sided-extraheavy-cast-aluminum-1234-p-742222.html?gclid=CPvel5Dm7s0CFY-DaQodGQEF5A
Vacuum tumblers	Daniels Food Equipment DVTS 200 Tumbler	http://food-equipment-sales.com/?page_id=960

Table 2: Frequency per Mechanism of Mechanical Tenderization and Enhancement of Beef in Wake, Durham, and Orange Counties

Mechanism		County		
		Wake	Durham	Orange
Mechanical Tenderization	Blade or needling	3	1	1
	tenderizing			
	Cubing	8	6	4
	Pounding	2	-	-
Enhancement with Liquid	Vacuum tumbling	2	-	-
	with liquid			
	Marinating/brining	1	-	1
	already tenderized beef			

Table 3: Models of Equipment Used to Mechanically Tenderize and Enhance Beef Products

Mechanism	Model
Hand-held needle or blade tenderizers	Chef-Master Blade Meat Tenderizer
	Jaccard Meat Tenderizer
	Steven Raichlen Marinade Turbocharger
Cubing devices	Hobart 403 Tenderizer
	Berkel Tenderizer
	Pro-Cut KT-8 Meat Tenderizer
Vacuum tumblers	Daniels Food Equipment DVTS 200

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CHAPTER 5

Fate of Shiga-toxin producing *Escherichia coli* (STEC) in Marinade and Brine Used in Vacuum Tumbling Beef

INTRODUCTION

In 1992 and 1993, undercooked ground beef contaminated with *Escherichia coli* (*E. coli*) O157:H7 and prepared at Jack-in-the-Box restaurants led to more than 500 illnesses and four deaths (2). As a response to this and other outbreaks and recalls in 1996, the Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA) declared *E. coli* O157:H7 in ground beef an adulterant, it is an added substance, likely to cause injury to human health (16, 18). In 1999, FSIS also added non-intact cuts of beef to the list of products where *E. coli* O157:H7 was classified as an adulterant (16). A non-intact raw product as being further processed using steps such as grinding, comminuting, injecting product with solutions, mechanical tenderization by needling, cubing, pudding devices, or other means (19). Other Shigatoxin producing *E. coli* were classified as adulterants in non-intact beef in 2012 (17).

Studies have shown that blade and needle tenderized beef sub-primal cuts, classified as non-intact, have an increased risk due to potential pathogen internalization (6, 13). Because the transference of pathogens from the exterior to the interior of muscle meats may require a higher internal temperature when cooking to ensure STEC are eliminated, validation studies regarding different cooking techniques for blade and needle tenderized

beef sub-primals have been conducted (7, 12). These types of studies are also needed to determine D-value for other forms of non-intact beef products like processes that incorporate marinade and brine. Non-intact beef products, such as cuts that have been blade and needle tenderized, cubed, vacuum tumbled, etc. can introduce pathogens when marinade and/or brine are incorporated into the process (16, 19).

Pathogens can persist in commercial marinades (9, 11). In one study two different commercial marinade formulations were used, Reo TAMU Fajita Marinade (Reo Spice and Seasoning, Inc., Huntsville, TX) and Legg's Cajún Marinade (A. C. Legg, Inc., Calera, AL); the dry marinade was mixed according to the manufacturer's instructions, one consisting of 272.15 g of dry seasoning, 29.93 g of sodium tripolyphosphate, and 1,391.14 ml of distilled water and the other consisting of 215.40 g of dry seasoning added to 986.87 ml of distilled water (9). Samples were inoculated with Rifampicin resistant strains derived from parent strains of *E. coli* O157:H7 and *Salmonella* Typhimurium (9). Post-vacuum tumbled marinade samples, having already been vacuum tumbled with beef, were kept at 4°C and sampled on days 0, 3, and 7 (9). Results showed that pathogens were able to survive at refrigerated temperatures within the spent marinade (9). Pathania and colleagues investigated commercial marinades used in poultry. Teriyaki and lemon pepper marinades were inoculated with three strains of *Salmonella* (Heidelberg, Typhimurium, and Senftenberg) and held at both 4°C and 25°C for up to 32 hours (11). Pathania et al. found that populations of all three strains of *Salmonella* were significantly reduced in the commercial teriyaki marinade over the 32-hour period as compared to the commercial lemon pepper marinade, regardless of storage

temperature, displaying that different ingredient formulation of marinade may play a role in the ability to reduce bacteria (11). Pathogens were able to persist through the 32-hour period in the majority of samples (11).

Cross-contamination of sub-primals cuts or steaks during processing may occur if marinade or brine is reused after coming into contact with beef containing STEC. This can also occur if equipment used to marinate or brine is not cleaned and sanitized properly before its next usage. Some commercial marinade and brine may instruct users to dilute out the product. Marinade and brine may also be diluted naturally as a result of coming into contact with liquid (juice, blood, etc.) from the beef itself. This is particularly of concern if marinade or brine is reused for multiple batches of vacuum tumbling, where spent marinade may have continuously picked up liquid or solid residue from previous batches. This study was performed to test the hypothesis that STEC persist in different formulations of full strength and diluted marinade and brine that could be used in the process of enhancing beef. STEC's ability to persist was tested by inoculating different types of marinade and brine, at various dilutions, with 8 strains representing 8 target serogroups of STEC. Results from this study can be used to make risk management decisions that can be made to reduce the likelihood of possible product contamination.

MATERIALS AND METHODS

Three types of marinade and brine, a commercial steakhouse-style marinade, a commercial teriyaki marinade, and a brine, were purchased or prepared (Table 1). Each

marinade or brine solution was formulated and diluted as follows: marinade or brine with no dilution or diluted with filter-sterilized deionized water to 75:25%, 50:50%, 25:75%, and 10:90%. Samples were inoculated with a rifampicin-resistant STEC-8 cocktail (O157:H7, O111:H-, O45:H2, O103:H2, O121:H19, O145:NM, O26:H11, and O104:H4) at approximately 7 log CFU/ml (Table 2) and stored at both 4°C and 15°C for up to 5 or 6 days (Table 3). One trial required sampling to be conducted on day 6 rather than day 5 due to limited building accessibility of restricted areas of a government building where the study was conducted. Results reported reflect this anomaly.

Sampling and microbial analysis. Inoculated marinade and brine samples were poured directly into test tubes. The test tubes were centrifuged before being plated, at appropriate dilutions, onto Sorbitol-MacConkey (Difco) plus rifampicin (100 mg/ml, Sigma Chemical Company; St. Louis, MO) agar plates. Sorbitol-MacConkey plus rifampicin was used to quantify the original rifampicin-resistant STEC strains. Each sample was plated in duplicate and incubated at 37°C for 24 hours. After culture incubation, colorless to slightly pink colonies were counted as STECs (15, 20).

Statistical analysis. One-way analysis of variance (ANOVA) was used to determine statistically significant differences in mean log CFU/ml of the different sampling days of marinades and brine at each temperature at each dilution. When one-way ANOVA detected statistically significant differences between mean log CFU/ml per day, a Tukey's honestly significant difference (HSD) test selected for when there was significance between day 0 and the final sampling day. Multivariate ANOVA using repeated measures was used to determine

statistically significant differences in storage temperature (4°C vs. 15°C) of mean log CFU/ml of day 0 to the final sampling day in the different marinades and brine at each dilution. A paired t-test using repeated measures was used to determine statistically significant difference in mean log CFU/ml of day 0 to the final sampling day in the different marinades and brine at each storage temperature when diluted.

RESULTS

Data were collected from three trials and the results are reported as an average of the trials combined. Data from two trials where sampling occurred on day 5 and data from one trial where sampling occurred on day 6 were averaged together. STEC-8 were recovered through at least 5 days in all samples of 25:75% and 10:90% and after 2 days in all sample of 50:50% steakhouse-style marinade (Table 4). STEC-8 were recovered after at least 5 days in all samples of 50:50%, 25:75%, and 10:90% and after 2 days in all samples of full strength and 75:25% teriyaki marinade (Table 5). STEC-8 were recovered after at least 5 days in all samples of the brine (Table 6). There were statistically significant differences ($p < 0.05$) in mean log CFU/ml from day 0 to the final sampling day in all steakhouse-style marinade samples and in teriyaki marinade at full strength, 75:25%, and 50:50% (both at 4 vs. 15°C) (Table 7). There were no significant differences in mean log CFU/ml from day 0 to the final sampling day in all brine samples (Table 7). There were no statistically significant differences ($p > 0.05$) in mean log CFU/ml from day 0 to the final sampling day among storage temperatures (4 vs. 15°C) in all three types of marinade and brine at each dilution

except for the steakhouse-style marinade at 25:75% (Table 4). There were significant differences in mean log CFU/ml from day 0 to the final sampling day in all samples (each of the three marinades/brine at each temperature) when diluting. Full strength marinade or brine achieved total reductions of ca. 2.1 to 2.26 log CFU/ml of steakhouse marinade, ca. 2.9 log CFU/ml for teriyaki marinade, and ca. 1.06 to 1.26 log CFU/ml for the brine.

DISCUSSION

Pathogenic *E. coli* generally cannot grow at temperatures $< 7-8^{\circ}\text{C}$, $\text{pH} < 4.4$, and a_w of < 0.95 (4). In varying levels of sodium chloride (NaCl), pathogenic *E. coli* has been shown to grow vigorously in 2.5% NaCl, grow slowly in 6.5% NaCl, and not grow in 8.5% NaCl (3). However, there are several studies regarding how pathogenic *E. coli* behave when subjected to varying levels of multiple factors like pH, temperature, sodium chloride, a_w , and the composition of the food medium itself (5, 8, 10, 14). Even the individual serogroups themselves may act differently to these factors (1). With little information available about the survival of pathogens in marinade or brine, more studies are needed taking into consideration the numerous characteristics that may influence the fate of STEC.

The statistically significant differences among various concentrations of the different marinades and brine could be due to a variety of factors such as ingredients, pH, and salt content. Although the steakhouse-style marinade and the teriyaki marinade had similar pH values at 25:75% and 10:90% dilutions, the steakhouse-style marinade was able to reduce STEC more effectively than the teriyaki marinade. Differences in ability to reduce STEC

while having similar pH values suggests that other elements in addition to pH aided in reducing STEC. Spices or other ingredient differences could have affected the difference in reducing STEC. The significant differences in mean log CFU/ml from day 0 to the final sampling day in all in teriyaki marinade at full strength, 75:25%, and 50:50% (both at 4 vs. 15°C) could indicate that full strength samples would be more effective at reducing STEC than the further diluted samples. Differences in ability to reduce STEC when diluting out the teriyaki marinade indicates that using full strength marinade and brine, contingent on the ingredient formulation, could potentially lessen the concentration of STEC, if present.

STEC-8 were recovered through at least 5 days in all samples of 25:75% and 10:90% steakhouse-style marinade, after 2 days in all samples (full strength to 10:90% dilution) of the teriyaki marinade, and through at least 5 days in all samples of the brine. This study demonstrates that if STEC are introduced at any point in the process of enhancing non-intact beef products, surviving cells can potentially cross-contaminate numerous other batches of meat via added marinade or brine.

Establishments that are enhancing beef products with marinade and brine can use this information to make improved risk management decisions. Because STECs were able to persist in multiple formulations of marinade and brine, among various dilutions, and at different temperatures, steps must be taken to reduce the initial introduction of pathogens. Steps to reduce the initial introduction of pathogens include using full strength marinade or brine and not reusing marinade or brine without an antimicrobial treatment. Novel education methods are needed to communicate risk information and successive risk mitigation

techniques to meat retailer personnel. These materials must be created in multiple languages to foster the usage of the resources among non-English speakers. Further studies are needed to determine the fate of STEC in different ingredient formulations of marinade and brine as the alteration of one ingredient can potentially have affects on the product's overall ability to control STEC. Because this study only implemented sampling between day 0 and day 5 or 6, other studies are needed to determine if STEC can persist for longer amounts of time in different formulations of marinade and brine. Studies could also use other pathogens in addition to STEC, such as *Salmonella* spp., which are associated with beef products.

Table 1: Ingredients Lists for Marinade and Brine

Marinade/brine	Ingredients
Steakhouse-style marinade	Water, hydrolyzed soy protein, vinegar, salt, natural hickory smoke flavor, corn syrup solids, modified tapioca, starch, malodextrin, molasses, garlic powder, sugar, spices, tamarind, natural flavor, sodium benzoate, potassium sorbate
Teriyaki marinade	Water and pineapple juice concentrate, high fructose corn syrup, soy sauce (water, soybeans, salt, wheat), salt, sherry wine, sugar, red wine vinegar, caramel color, spice, food starch-Modified, garlic powder, xanthan gum, sodium benzoate, citric acid
Brine	Food grade sodium tripolyphosphate, sodium chloride, filter- sterilized deionized water

Table 2: Averages of pH of Marinade and Brine Post Inoculum on Day 0

Marinade/brine	Dilution				
	Full strength	75:25%	50:50%	25:75%	10:90%
Steakhouse-style marinade	3.94	3.97	4.0	4.1	4.26
Teriyaki marinade	3.69	3.67	3.79	3.9	4.1
Brine	7.95	8.24	8.36	8.63	8.71

Table 3: Experimental Matrix of Marinade/Brine at Storage Temperatures and Dilutions

Marinade/brine	Storage	Dilution				
	temperature	Full strength	75:25%	50:50%	25:75%	10:90%
Steakhouse-style marinade	4°C	Full strength	75:25%	50:50%	25:75%	10:90%
	15°C	Full strength	75:25%	50:50%	25:75%	10:90%
Teriyaki marinade	4°C	Full strength	75:25%	50:50%	25:75%	10:90%
	15°C	Full strength	75:25%	50:50%	25:75%	10:90%
Brine	4°C	Full strength	75:25%	50:50%	25:75%	10:90%
	15°C	Full strength	75:25%	50:50%	25:75%	10:90%

Table 4: Averages of Log CFU/ml for Steakhouse-Style Marinade at 4°C and 15°C

Temperature	Sampling day	Dilution				
		Full strength	75:25%	50:50%	25:75%	10:90%
4°C	0	2.26	3.22	3.65	3.85†	3.85
	1	0	0	1.61	3.3	3.32
	2	0	0	0.53	2.91	1.65
	Final	0.16	0	0	1.5†	1.65
	day*					
15°C	0	2.26	3.22	3.65	3.83†	3.83
	1	0	0	1.69	3.34	3.62
	2	0	0	0.5	2.76	1.56
	Final	0	0	0	0.13†	1.56
	day*					

*Final day consisted of averages between sampling that occurred on days 5 and 6

† Notes statistically significance differences in mean log CFU/ml from day 0 to final day among storage temperatures (4 vs. 15°C)

Table 5: Averages of Log CFU/ml for Teriyaki Marinade at 4°C and 15°C

Temperature	Sampling day	Dilution				
		Full strength	75:25%	50:50%	25:75%	10:90%
4°C	0	2.9	3.38	3.51	3.71	3.76
	1	1.43	2.09	3.06	3.38	3.62
	2	0.36	1.27	3.33	3.45	3.54
	Final	0	0	2.04	3.31	3.33
	day*					
15°C	0	2.9	3.38	3.51	3.71	3.76
	1	0.8	2.16	2.97	3.4	3.61
	2	0.47	1.6	2.51	2.84	3.21
	Final	0	0	1.86	2.89	2.31
	day*					

*Final day consisted of averages between sampling that occurred on days 5 and 6

Table 6: Averages of Log CFU/ml for Brine at 4°C and 15°C

Temperature	Sampling	Dilution				
	day	Full strength	75:25%	50:50%	25:75%	10:90%
4°C	0	1.56	1.38	1.87	2.56	3.71
	1	1.41	1.14	1.37	2	3.29
	2	1.22	1.21	1.5	1.82	3.05
	Final	0.27	0.5	0.29	0.98	2.62
	day*					
15°C	0	1.56	1.38	1.87	2.56	3.71
	1	1.36	0.8	1.46	2.24	3.47
	2	0.78	0.72	0.74	1.71	3.37
	Final	0.5	0.62	0.64	1.47	2.87
	day*					

*Final day consisted of averages between sampling that occurred on days 5 and 6

Table 7: Statistically Significance Differences in Mean Log CFU/ml from Day 0 to Final Day

Dilution	Marinade					
	Steakhouse-style marinade		Teriyaki Marinade		Brine	
	4°C	15°C	4°C	15°C	4°C	15°C
Full strength	†	†	†	†	-	-
75:25%	†	†	†	†	-	-
50:50%	†	†	†	†	-	-
25:75%	†	†	-	-	-	-
10:90%	†	†	-	-	-	-

†: Significant at $p < 0.05$

-: No significant difference

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CHAPTER 6

CONCLUSIONS

Consumers must be provided with adequate food safety messages to make educated decisions about the foods that they prepare and consume. Food safety education and risk communication must contain information that is accurate, accessible, and understandable. This research aimed to explore current food safety initiatives for consumers and risk communication practices at retail fit those characteristics. The various studies incorporated into this thesis reveal gaps, needing to be addressed, in food safety education and risk communication.

Food safety messages must be targeted towards specific populations to maximize effectiveness. The review of food safety messages discloses that while many food safety educators do target specific populations, there is a disproportion of information disseminated between certain populations. Underserved populations for food safety initiatives were identified as farmers market vendors and ethnicity/minority populations. Educational materials are needed to cater to these groups as their food consumption, food safety practices, and communicable risks may be different than the current populations of interest. Materials will need to be created in multiple languages so that non-English speakers in other groups can also access and use the resources.

The channels in which food safety information for consumers is delivered can be expanded to magnify reach and accessibility. Although there are benefits to delivering

information to consumers in person, extensive reach is limited. The Internet, including social media platforms, continues to evolve as a major source for consumers' obtainment of health information (cite). Like in-person education, the Internet and social media can be used to engage with consumers in that it can often create an open dialogue between its users. These conversations can be made public to engage even more individuals. Other outlets for disseminating information that could potentially have a broad reach are also underused. Few survey participants indicated radio and television as being used as an outlet for conveying food safety education to consumers. Every method of delivering food safety information has its advantages and disadvantages, thus, it is important that a multichannel delivery system approach is used.

Evaluations should be conducted by those who contribute to consumer food safety education efforts. Evaluating programs and other initiatives allows for necessary programming adjustments to be made, if necessary, on both a short-term and long-term basis. This also allows for the allocation of resources to be revisited in a way that maximizes efficiency. Measuring impacts makes it possible for key stakeholders to be updated about their investments (i.e. finances, time, or general concern for the nature of the work being done). Evaluation must also be measured in ways that are both accurate and precise. Those that deliver programs/content must be certain that they are measuring what is actually intended to be measured and doing so in a way that can be replicated. Food safety communicators should learn how to best approach evaluations within their own programming activities and may want to incorporate a third party to reduce bias. More materials should be

made obtainable to those that are not as willing to contribute extensive resources towards evaluation efforts.

The results of the investigation of consumer message delivery (Chapter 3) were presented at the 2014 National Consumer Food Safety Education Conference as a keynote presentation. Individuals attending this conference are customarily those involved in food safety communication for consumer populations. This research was also used to shape the goals and objectives for the 2017 National Consumer Food Safety Education Conference, “advancing food safety through behavior change.” The research has been used to further encourage stakeholders in consumer food safety education programs that scientific studies are needed to influence the direction of future efforts. Stakeholders have now been informed about the gaps in food safety education to consumers so that they can be addressed by those that conduct these types of educational efforts.

Focusing in on the gap of safe sources, it was found that personnel at establishments serving raw and steamed oysters are not prepared to be adequate risk communicators (Chapter 4). Since restaurant personnel do not serve as adequate risk communicators and because this study displayed that there may not be other written consumer advisory warnings outside of what is required to be disclosed in the menu, more avenues for communicating risks are needed. Risk information can be delivered through different channels and executed in several ways. While restaurant personnel may serve as risk communicators when promoted by customers, they can take a proactive approach by alerting and reminding patrons of the potentially risks associated with consuming undercooked oysters. Hanging

signs can be posted throughout the restaurants in various locations; where customers first walk into the establishment, places that can be seen while the customer is seated, and specifically in settings such as the bar area of a restaurant where patrons are more likely to order undercooked oysters.

Recommendations can be made at the 2018 Conference for Food Protection Biennial Meeting to require more training in risk communication practices for restaurant employees handling and serving undercooked shellfish. This meeting promotes food safety and consumer protection by identifying and addressing problems in the food chain while successively adopting sound and uniform procedures to which can assist in solving these problems (1). Additionally, food safety education efforts must create and implement messages intended for consumers that address the risks associated with steamed oysters in addition to raw oysters. As consumers may perceive steamed oysters as being fully cooked, it is important to make them aware that there are still risks present.

An issue should be presented at the 2018 Conference for Food Protection Biennial Meeting to require more training in risk communication practices for restaurant employees handling and serving undercooked beef products. The 2016 Biennial Meeting brought about discussion over whether restaurant servers were adequate risk communicators pertaining to undercooked hamburgers. Although no issues were passed regarding additional risk communication training for restaurant employees, committees have been established to further explore this opportunity.

Due to the USDA FSIS labeling rule mandating labeling of needle and blade tenderized raw beef products not taking into consideration other types of mechanical tenderization such as cubing, pounding, and vacuum tumbling, meat market personnel should be educated about the ways in which they can reduce potential risks in their businesses. These educational materials must be created in multiple languages as many of the independent meat retailer employees participating in this study were non-English speakers. Meat retailers that do process beef in ways that will fall under the new labeling rule still need to be trained and educated in ways that support good risk communication practices as well as safe practices for handling these types of high-risk products. It is important for meat retailer personnel to understand why these products are classified as being higher risk than other beef products and to share with them why they should care about the heightened risk.

An issue should be presented at the 2018 Conference for Food Protection Biennial Meeting to make changes to the FDA Model Food Code definition of mechanically tenderized as it conflicts with the new USDA FSIS rule for the labeling of needle and blade tenderized raw beef products. Once again, issues submitted to the 2016 Biennial Meeting generated discussion about regulations surrounding the labeling and usage of mechanically tenderized beef products at retail. In regards to the intended use for raw beef source materials, the 2016 conference group recommended that a letter be sent to USDA FSIS to discuss better ways of labeling this information to retail operators for whole-muscle intact beef to remain whole-muscle intact beef at the retail level (cite CFP issues). Additionally, recommendations can be made at the 2018 Conference for Food Protection Biennial Meeting

to disclose information about the risks associated with mechanically tenderized and enhanced beef products on restaurant menus serving these types of products. While a written consumer advisory warning is required to be located within restaurant menus serving undercooked beef, there is no information available for consumers to recognize that the beef products in which they may receive at foodservice establishments could potentially be mechanically tenderized or enhanced. More attention can be brought to the discrepancies and inconsistencies of regulations surrounding mechanically tenderized and enhanced beef products.

As STEC-8 were recovered after 5 to 6 days in all samples of inoculated marinade and brine, this study can be used to educate meat market retailers about the risks associated with using marinade and brine in conjunction with beef products. Again, these materials must be created in multiple languages to foster the usage of the resources among non-English speakers. Educational materials must highlight the importance of good food safety practices when using marinade and brine such as using at full strength, not reusing spent marinade or brine (without an antimicrobial treatment) and implementing effective cleaning and sanitation of equipment.

The data collected from this thesis reflects that there are gaps in messages related to safe sources in food safety education and risk communication efforts for consumers. Gaps in safe source messages were present in food safety education and risk communication in consumer-specific food safety education materials, at foodservice, and at retail. Messages must be created to address the wide variety of safe source issues. Current food safety

messages do not teach consumers how to make good food choices outside of the home.

Messages should serve as a guide for how consumers should acquire more information about food they are purchasing; specifically consumers need to know what types of questions should be asked in order to receive information that can be used to make risk-reducing decisions.

REFERENCES

1. Conference for Food Protection. 2016. Conference for Food Protection. Available at:
<http://www.foodprotect.org>

APPENDICES

APPENDIX A

Questionnaire for Food Safety Educators

We are conducting an environmental scan of organizations and individuals who provide food safety educational programming to consumers – individuals who purchase food for personal consumption and use. We want to include your work in this public/ private sector “mapping” project. Your response helps contribute to a much richer and deeper picture of food safety education activities in the United States.

If you fully complete the survey, you will be entered in a drawing for a \$250 gift card. Thank you in advance!

1. Please provide your first and last name.

2. What is your preferred phone number?

3. What is your preferred email address?

4. What organization do you represent?

5. Would you prefer to complete this survey via phone call? If so, please provide the best time of day to be contacted at the phone number which you have provided (I.e. morning, afternoon, evening).

 No
 Yes (include best time of day to be contacted)

6. Does your organization provide food safety education to consumers?

 Yes
 No

I don't know

7. Which best describes your organization?

- Public health
- Federal government
- Academia
- School system (K-12)
- Food retail
- Industry trade groups
- Non-profit
- Other (specify)

8. Which best describes your public health organization?

- Local public health agency
- County public health agency
- State department of health
- State department of agriculture
- Other (specify)

9. Which best describes your federal government organization?

- Under the Healthy People 2020 framework
- United States Department of Agriculture (USDA)
- Food and Drug Administration (FDA)
- Centers for Disease Control and Prevention (CDC)
- Women, Infants, and Children (WIC)
- Food Safety and Inspection Service (FSIS)
- Expanded Food and Nutrition Education Program (EFNEP)
- Supplemental Nutrition Assistance Program Education (SNAP-ED)
- Other (specify)

10. Which best describes your organization within academia?

- Cooperative Extension (Family and Consumer Sciences)
- Cooperative Extension 4-H
- Hospitality
- Medical or Public Health
- Agricultural and Life Sciences
- Veterinary Medicine
- Other (specify)

11. Which best describes your role within the school system (K-12)?

- Family and consumer science teacher
- Science teacher
- Health teacher
- Other (specify)

12. Which best describes your organization within food retail?

- Chain
- Independent
- Other (specify)

13. Which best describes your organization's role within industry trade groups?

- Food manufacturer
- Consumer product company
- Other (specify)

14. Which best describes your non-profit organization?

- Food bank
- Food pantry

- Congregate nutrition program
- Other (specify)

15. Does your organization provide multiple food safety education programs to consumers?
If so, how many?

*If you answer "Yes", please continue the survey with only one food safety education program in mind. You will be asked at a later time if you would like to fill out the survey for additional programs. You may fill out information for a total of five programs.

- No
- Yes (specify)

16. What is the main message of your organization's food safety education program? (I.e. Source of food, Cook, Clean, Chill, Separate, Report illness, Hygiene, Proper Storage, High risk populations, etc.)

17. What program platform is used? Check all that apply.

- Fight BAC
- Food Safe Families
- Be Food Safe
- Cook It Safe
- None of these
- Other (specify)

18. Who is the programming/ outreach activity designed to reach? Check all that apply.

- Children/ students (K-12)
- Pregnant women
- Adults with children at home/ primary meal preparers

- Adults without children
- Elderly (60+ years old)
- Mixed community audience of adults and kids
- Other food safety educators
- People who are buying food
- Ethnicity based
- Low income populations
- Farmers market vendors
- Other (specify)

19. Who executes the outreach programming?

20. Through what type of channel is the program delivered?

- In person
- Online (email, website, social media, etc.)
- Television
- Radio
- Other (specify)

21. How many people does this/ these educator(s) reach annually?

- Less than 50
- 50 - 100
- 101 -500
- 501 – 1,000
- 1,000 +

22. Is there a lead educator or person who designed the outreach programming?

- No

- I don't know
- Yes (explain role and title)

23. How long has this educator been conducting this outreach program?

- Less than one year
- 1-5 years
- 6-10 years
- 11-20 years
- 20+ years
- I don't know

24. Does your organization measure impacts of the outreach program?

- Yes
- No
- I don't know

25. How are these impacts measured?

26. How are the programming/ outreach efforts funded?

27. If your organization provides multiple food safety education programs for consumers, please answer the survey questions based upon each of these individual programs.

Would you like to fill out the survey for an additional food safety education program that your organization provides?

- No
- Yes (will redirect you to the previous survey questions)

*Survey participants will be able to answer questions about up to 5 different programs.

28. Is your organization registered online as a BACFighter?

- Yes
- No
- I don't know

29. Are there any differences between your organization's practices and those that are contained within the Fight BAC! basic brochure? If so, please explain.

30. Do you give permission for the Partnership of Food Safety Education to contact you in the future?

- Yes
- No

31. Can you connect us with additional participants that may provide food safety education to consumers?

- No
- Yes (specify)

32. Would you like to provide us with any additional information or comments?

- No

Yes

APPENDIX B

Interview for Restaurant Personnel at Restaurants Serving Raw and/or Steamed Oysters

1. Does your establishment serve raw oysters?
2. Does your establishment serve steamed oysters?
3. Can you describe your steaming process for oysters (details like how many are placed into the steamer, how long, at what temperature, etc.)?
4. What happens to oysters after steaming if they do not open? Are they used or discarded?
5. From what states do you receive your oysters?
6. Does the time of year affect the supplier/location of where you receive your oysters from? How so?
7. What is the method of shipment used for your oysters?
8. How long are oysters typically held in your cooler?
9. Do you have a written consumer advisory regarding undercooked oysters? If so, where is your consumer advisory located?
10. What methods do you use, if any, to track possible foodborne illness outbreaks?
11. Do you keep the tags from your oyster shipments? If so, how long do you keep the tags?
12. Are your oysters processed in any way to reduce foodborne illness risks? If so, how?

13. If asked, by a customer whether steamed oysters are fully cooked, meaning they are free of all foodborne pathogens, how would you answer?
14. Are you aware of any foodborne illnesses associated with undercooked oysters?
15. In the past, has your restaurant had any reported cases of norovirus due to raw or steamed oysters? If so, when, and have you made any changes since then to prevent anymore and what would those changes be?
16. Do you know of any other restaurants I could contact?

APPENDIX C

Interview for Meat Retail Personnel at Establishments Serving Beef

Hello! I'm a student from NC State conducting research for a summer project. I'm trying to better assess the practices involved in mechanically tenderizing beef products at retail. May I speak to a manager to ask them a few questions about how your establishment handles mechanically tenderized beef? The survey should only take about five minutes.

1. Are you the manager?

Yes or No

One common type of meat tenderization is mechanical tenderization using needles or blades to break-down and penetrate the muscle fibers. Tenderization can also occur when marinade or tenderizing solution is injected into the muscle fibers.

2. Does your establishment mechanically tenderize beef products here? This could include cubing, jaccarding, blade, or needle tenderizing.

Yes or No

3. Does your establishment inject marinade or tenderizing solution into beef products here? This could include needle injection, vacuum tumbling with marinade or brine, or marinating before mechanical tenderization.

Yes or No

4. [If answered "Yes" to questions 2 and/or 3] What types of equipment are being used to perform the process/processes you had previously listed? Could you provide me with a list of brands and model numbers?

5. How are these pieces of equipment cleaned and sanitized (process, name or type of cleaner and sanitizer, frequency, etc.)?

6. What types of beef products (type of cut, thickness, etc.) are being processed this way? (Specify what type of products are used for each of the processes above)

7. How long are the products stored before they are mechanically tenderized?

8. At what temperature are the products stored before mechanical tenderization?

9. How long are the products kept after they are mechanically tenderized?
10. At what temperature are the products stored after mechanical tenderization?
11. [If answered “Yes” to question 3] What is the brine/ marinade made up of? Is it commercially sold?
12. Is the brine/ marinade ever reused more than once?
13. At what temperature is the brine/ marinade kept?
14. Would you like us to provide you with information about the safety of the process?

Yes or No