Mechanically Tenderized Meat: A Survey at the Retail Level

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Abstract:

Background: In 2012, mechanically tenderized meat raised public health concern when an *E.Coli* 0157:H7 outbreak was linked to the tenderization process. It was discovered that the machinery pushed the *E.Coli* from the surface of contaminated meat products such as steaks and roasts, into the interior, where it was able to survive the cooking process. Concerns were raised by Lorraine McIntyre and the BCCDC about this issue, and their desire to improve their knowledge base in order to adequately assess the risk.

Methods: Data was gathered via a survey conducted electronically and by telephone. Questions were asked to determine the proportion of retail establishments that use their own tenderizing equipment. Questions also asked about other industry practices such as current sanitization and labeling practices.

Results: The results of this study were that 24% of surveyed establishments mechanically tenderize their meat products. Of these establishments, 33% have a label that states the meat has been tenderized mechanically and 17% provide cooking instructions on this label. An association was found between mechanically tenderizing meat and establishment type, which suggests that grocery stores are more likely to mechanically tenderize than other establishments, such as restaurants. On the other hand, no association was found between operator experience and their level of knowledge regarding the risks of mechanical tenderization.

Conclusions: Overall, this study has demonstrated the likelihood is high that consumers purchase and consume beef that has been mechanically tenderized at the retail level. The results from this study can be used to aid public health officials in quantifying the risk of mechanical tenderization at a retail level and aid in the development and implementation of new legislation such as mandatory labeling of all mechanically tenderized meat

Keywords: mechanically tenderized meat (MTM), food safety, food retail establishment, survey, labeling

Introduction

At a consumption of 13.3 kilograms per person, beef products constitute a significant portion of the typical Canadian diet (Statistics Canada, 2002). Upon purchase, consumers expect their meat products to be safe for consumption when cooked and handled properly, putting their trust in meat processors, retailers, and government officials to ensure the safety of their food. However, there is the potential for raw meat products to become contaminated during the stages of processing with disease causing microorganisms which could survive an inadequate cooking process (Health Canada, 2012).

Escherichia coli O157:H7 is a pathogenic bacterium that has a history of being associated with beef products. The link between *E. coli* infection and beef is so well known that the diagnosed illness used to be called hamburger disease. The disease affects the gastrointestinal tract, causing mild to severe diarrhea, and can also lead to more serious side effects and death (BCCDC, 2012). As judged from the number of cases reported through the British Columbia Annual Summary of Reportable Diseases (2012), foodborne illness caused by *E. coli* O157:H7 remains a significant cause of illness, and continues to be implicated in numerous outbreaks worldwide (Catford et al., 2013).

Before reaching consumers, cuts of meat such as steaks and roasts may be tenderized to improve the quality of the meat. If beef is properly aged, it does not need to be tenderized; however, with the current demand and lack of storage space, processers have been shipping meat to retailers very quickly, sometimes within 48 hours of slaughtering (McIntyre, Peters, & Shyng, 2012). Since this meat has not had enough time to properly age, it is tougher, and requires tenderization before being sold to the customer. Under normal circumstances, the heat from grilling a steak will kill pathogens located on the outside surface of the meat, but mechanical tenderization can push microorganisms into the interior, where they can survive the cooking process and cause illness when consumed. In 2012, illness from *E. coli* linked to mechanically tenderized meat raised public concern regarding the potential health risk associated with this process. The desire to prevent further incidents has prompted the incorporation of different types of control measures to protect Canadians from potentially unsafe food (CFIA, 2012).

Currently, there is little knowledge of how many food retail establishments utilize tenderizing equipment on their beef products in British Columbia. However, according to Health Canada (2012), the practice is very common among suppliers, retailers, and restaurants, who utilize the process in order to improve the tenderness and flavor of low quality beef (VCH, 2013). Concerns were raised by Lorraine McIntyre and the British Columbia Center for Disease Control about the lack of information regarding mechanical tenderization at this level, and their need to improve their knowledge base.

Literary Review

Beef as a Potentially Hazardous Food

Beef products are classified by Health Canada (2012) as a raw food of animal origin. Raw meat is extremely vulnerable to contamination by disease causing microorganisms because it is high in moisture and nutrients that bacteria require to grow and multiply. Contamination can also occur because animals may carry pathogenic organisms from before they were slaughtered. For example, *E. coli* O157:H7 is commonly found in the gastrointestinal tract and feces of healthy cattle (BCCDC, 2012). Cattle are considered to be the most important animal reservoir contributing to the introduction of *E. coli* into the food chain because of the potential for contamination during the slaughter and production process. If the bacteria is present in the feces of the animal, it can be transferred to the hide, and then into the carcass through the de-hiding process. Knives and equipment can also become contaminated, transferring the bacteria onto additional cuts of meat (Laury, Echeverry, & Brashears, 2009). This chain of events has potential to cause a massive amount of contamination from a single source.

There are a variety of cuts of beef and a diversity of processing options that can be performed before being distributed and sold to consumers. The National Cattlemen's Beef Association (2011) describes how these products can be classified as either whole-muscle intact beef products, or non-intact beef products. Non-intact products include beef that has been mechanically tenderized by needling, cubing, or pounding devices, injected with enhancing solutions (for example, marinades, brines), restructured into formed entrees, and ground (Mukerjee et al., 2009). Unlike intact cuts, there is a risk associated with the processing of non-intact beef. The primary concern is the introduction of harmful microorganisms such as *E. coli* from the meat surface to the interior of the muscle. An added risk is that the meat may be cooked so that the contaminated interior does not meet the required temperature of 71^{o}C to properly destroy any pathogens that are present.

The Mechanical Tenderization Process

As processors today attempt to increase the tenderness and juiciness of their whole beef cuts, they are turning to blade or needle tenderizing to enhance the quality of the meat (Pellegrini, 2013). These processes, otherwise known as mechanical tenderization, are procedures in which large pieces of meat are penetrated in several directions by sets of stainless steel needles or double edged blades, and then cut into steaks and roasts. Sometimes the needles used are hollow, allowing for the injection of flavorings or digestive agents. The needles or blades penetrate the meat by cutting through muscle tissues and fibers rather than tearing the tissue or punching holes (US Department of Agriculture, 2002). Mechanical tenderization is a used to increase the quality of meat, and may be used by suppliers, retailers, and restaurants, and sometimes even by consumers at home. It is very difficult to tell if a piece of meat has been mechanically tenderized unless it is labeled as such (New Brunswick HA, 2013).

Risk Analysis

Tenderized products may pose a health risk if pathogenic organisms, such as *E. coli* O157:H7, are moved from the surface of the meat into the interior of the product. In fact, the farm to fork risk assessment model developed by the Public Health Agency of Canada (PHAC) has predicted that the risk of consuming mechanically tenderized beef is 5 times greater than consuming an intact beef cut (Catford et al., 2013). With solid, whole intact cuts of beef, any harmful bacteria will only exist on the outside surface and be destroyed during the cooking process (New Brunswick HA, 2013). For example, cooking a steak to rare will sear the outside of the meat, killing bacteria located on this exterior surface. For food safety standards, this is considered safe since the interior of whole cuts are sterile. However, mechanically tenderizing beef can spread surface contamination to the inside of the meat. This means that the meat must be cooked so that harmful organisms are destroyed throughout the entire meat product, not only on the surface. Internalized bacteria are equally susceptible to heat stress, but an adequate internal temperature must be reached for their inactivation (Health Canada, 2012).

Cross Contamination

In modern day processing, line speed, or the amount of meat processed per hour, can be incredibly fast. Because of this speed, there is little time for sanitizing in between. If the tenderization equipment becomes contaminated and is improperly cleaned and sanitized, the equipment may become a vehicle of contamination. (National Cattlemen's Beef Association, 2011). For example, if an *E. coli* contaminated piece of meat comes into contact with tenderizing blades, the blades may also become contaminated. If this occurs, the equipment can then introduce bacteria into each subsequent piece of meat it comes into contact with. In addition, employee's gloves, cutting boards, and utensils can become contaminated, which can further spread bacteria to other pieces of meat.

Related Outbreaks

E. coli contamination has been a major concern in the meat industry for decades, and concerns have been increasing with the multitude of processing techniques. There have been outbreaks in both Canada and the United States that have raised concerns regarding non-intact products such as tenderized roasts and steaks, and that they may represent an increased risk of illness relative to intact muscle cuts (Catford et al., 2013). Table 1 refers to the most recent outbreaks.

Year	Type of meat	Location	Cases
2000	needle tenderized sirloin steaks	USA	2
2003	boneless beef filet bacon-wrapped steak product injected with marinade	USA	11
2004	tenderized, marinated beef steak product	USA	4
2009	blade tenderized steaks	USA	21
2012	needle tenderized steaks	Canada	5

Table 1: Recent Cases of Foodborne Illness Linked to Mechanically Tenderized Meat

The largest recall of beef products in Canadian history took place in the later months of 2012. This high priority recall was initiated after the presence of *E. coli* O157:H7 was discovered in products that were traced back to the XL foods plant in Brooks, Alberta. As a result of this contamination, an estimated 4,000 tonnes of beef was recalled and destroyed, representing at least 12,000 head of cattle (Government of Canada, 2013). Even so, there were a total of 18 cases of foodborne illness reported that were linked to this contaminated beef. Fortunately, there were no fatalities. During the food safety investigation associated with the outbreak it was determined that some of these illnesses were likely associated with the consumption of mechanically tenderized beef. Moreover, this beef had been tenderized at the retail level (Catford et al., 2013).

The XL recall raised awareness of both the public and scientific community regarding the practice of the mechanical tenderization of beef. Since this incident was such a large scale problem, it had the potential to cause drastic consequences for the public. Since XL meats processes 35% of the beef in Canada (Government of Canada, 2012), if the *E. coli* was not detected and recalled, many consumers could have become ill and possibly suffered more serious complications.

E. coli O157:H7 and Related Health Effects

Escherichia coli are a large and diverse group of bacteria. Although most of this group are harmless to human health, one of the most common pathogenic strains, *E. coli* O157:H7, can cause a toxico-infection of the intestinal tract, leading to a variety of gastrointestinal symptoms. For example, severe watery diarrhea, which can sometimes be bloody, vomiting, and stomach cramps are all common warning signs. These bacteria are found in the intestines and feces of cattle, poultry, and some other animals (Government of Canada, 2012). Infection in humans can occur once something is consumed that has become contaminated. Transmission is most commonly through drinking water and meat, especially beef. Please refer to figure 1 for a visual representation of sources.

Certain population groups are more likely to be negatively affected by illness with *E. coli*. Pregnant women, young children, the elderly, and people with weakened immune systems are at higher risk of suffering more serious complications (New Brunswick HA, 2013). Approximately 15% of children who are diagnosed with an *E. coli* infection develop a potentially life threatening complication known as hemolytic uremic syndrome (HUS). Of these individuals, approximately 50% will require dialysis, and 5% will suffer permanent kidney damage or die (BCCDC, 2013). Surveillance performed by the Public Health Agency of Canada (2013) reports an average of 440 cases of *E. coli* O157:H7 annually; however cases are usually unreported, with studies suggesting a mean estimate of 313 community cases per one reported case (MacDougall et al., 2007).

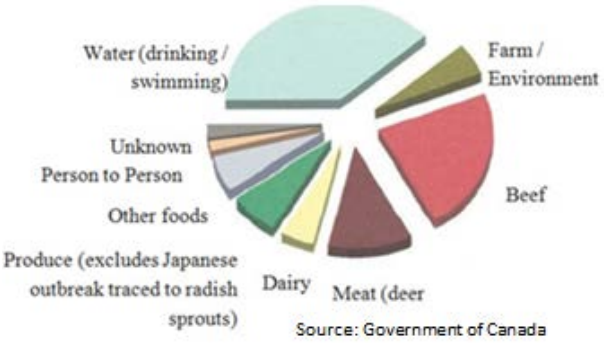
Control Measures

There are a variety of control measures that can be undertaken throughout the entire beef production process, from a farm to fork perspective. Care can be taken to prevent contamination from the raising of the cattle, through slaughter, processing options, retail, and even at the consumer level. Operators who practice meat tenderization should consider that a contaminant such as *E. coli* could find its way into the processing environment, and proper practices and procedures should be in place to identify and eliminate hazards to prevent further contamination and illness.

Cleaning and Sanitization

Since tenderizing equipment has the potential to harbor and spread microorganisms, operators need to recognize and address the risks. Implementing a sanitation program is an effective strategy which may help prevent a contamination problem during the mechanical tenderization of beef products. In 2006, the Beef Industry Food Safety Council developed some standard practices as guidelines to limit possible bacterial contamination of mechanically tenderized beef. Some of the recommended practices include daily needle removal and soaking in sanitation solution. Another antimicrobial reduction strategy is to continuously rinse tenderizing blades or needles with a sanitizing agent between uses to minimize cross contamination between different pieces of meat.

Figure 1: E. coli Cases Worldwide 1982-2006



In regards to restaurant and retail food establishments such as grocery stores and butcher shops, a written sanitation plan is required by law in British Columbia. This plan should include the cleaning and sanitizing requirements for the establishment, all equipment and utensils used, as well as the identification of sanitizing agents used and their respective concentrations. As of 2013, an amendment was added specifying that a sanitation plan is now required for premises where carcasses are handled or where food is processed or prepared (Food Premises Regulation, 1999).

Additional Food Safety Practices

The importance of employee training regarding the principles of food safety must also be recognized. Key areas of training to focus on are personal hygiene and the understanding of the required sanitation procedures (Government of Canada, 2012). Concentrating on both of these practices will help minimize the risk of cross contamination due to unsanitary employee behaviors and equipment that has been improperly cleaned and sanitized. In addition, regular inspections and education by government officials such as Environmental Health Officers are critical to monitor these practices and ultimately reduce the likelihood of transmission to humans (BCCDC, 2012).

Labeling

As part of the Safe Food for Canadians Action Plan, and because of the identification of mechanically tenderized meat as an increased food safety risk, federally registered meat plants must label mechanically tenderized beef cuts intended for retail sale (CFIA, 2013). In addition to labeling, they also have to communicate the appropriate safe cooking and handling instructions on their packaging. The Canadian Foodservices and Restaurant Association (2013), claims that this labeling will be helpful for operators who may not be aware of how their beef has been treated. However, at this point, provincial plants and retail establishments such as restaurants and supermarkets are only being encouraged to voluntarily label their products that have been mechanically tenderized. Just recently, Health Canada proposed amendments to the Food and Drug Regulation that would require mandatory labeling for Mechanically Tenderized Beef even at the retail level (Regulations Amending the Food and Drug Regulations, 2014). This proposal is currently under review.

Guidelines and Legislation

To protect Canadian families from potentially unsafe food, the government of Canada adopted the Safe Food for Canadians Act, which received royal assent on November 22, 2012 (CFIA, 2012). This new Act consolidates four other Acts, including the Federal Meat Inspection Act, and aims to make food as safe as possible. The Act will protect consumers through means such as targeting unsafe practices, implementing tougher penalties, and providing a more consistent inspection regime.

According to Health Canada (2013), policies and guidelines to assist in the management of the potential health risk associated with mechanically tenderized beef products have been developed by the United States, however there are no such policies or guidelines in Canada. Starting in December of 2012, Health Canada did begin a review of the science around the safe handling and cooking of mechanically tenderized beef. The assessment will take into consideration how mechanically tenderized beef is handled all throughout all levels of processing. Results of this review will be used to determine what advice should be distributed to industry and consumers regarding the management of related risks.

Growing Public Health Implications

Contamination of beef with pathogens such as *E. coli* is a public health concern due to the outbreaks of foodborne illness commonly associated with the consumption of these products. *E. coli* is a pathogen of special importance due to the severity of illness, and the potential for complications, such as hemolytic uremic syndrome (HUS) to develop, especially in younger children. The model developed by the Public Health Agency of Canada has predicted that the risk of consuming mechanically tenderized beef is 5 times greater than consuming an intact beef cut (Catford et al., 2013), since the bacteria can become inserted into the interior of the meat, where it may survive the cooking process. It is unclear exactly how much meat processed in Canada undergoes mechanical tenderization, but the Public Health Agency of Canada speculates that it could be between 20 to 50 percent (VCH, 2013).

Gaps in Understanding and Purpose of Study

It is unclear exactly how many, and which types of establishments use mechanical tenderization. However, it is estimated the capacity for tenderization at the retail level is 3 times greater than at the processing level (Catford et al., 2013). Due to the recognition of mechanical tenderization as a potential health hazard, it is critical to update food safety concerns and develop new interventions in order to successfully monitor and reduce the risk to the public. The purpose of this study is to determine the number and variety of food retail establishments (butcher shops, restaurants, grocery stores) performing in-house mechanical tenderization, the details of their sanitation plan, and if they label their mechanically tenderized meats. This will be done by surveying food establishment operations throughout British Columbia and comparing the responses of different groups. The knowledge of which establishments have this equipment could be used to aid public health officials in quantifying the risk of mechanical tenderization at a retail level. In addition, the results of this research could enable

Environmental Health Officers to tailor their inspections and educate operators regarding the associated hazards. Ultimately, by increasing awareness of the concerns of mechanical tenderization, the potential for foodborne illness can be reduced.

Methods and Materials

Description of Methods

This study was conducted using data collected by means of an electronic survey. The survey was created and distributed using an online platform provided free of charge by Google to anyone who creates an account. Google Docs (2014) provides a popular online survey tool that allows for easy survey design and data collection. In addition, the service provides analytical tools that can aid in summarizing data and investigating trends. Once the survey was created, it was distributed by means of e-mailing participants a link to the survey. The survey was sent to a variety of food retail establishments including butcher shops, grocery stores, restaurants, and beef processors.

The selection of food retail establishments ranged throughout the Province of British Columbia. The contact information of the food premises was obtained through online means such as company websites and Facebook pages. In addition, participating Health Authorities provided contact information, and the BC Small Scale Food Processors Association volunteered to distribute the survey to their members. In order to keep track of the selected participants, the contact information was recorded in a Microsoft Excel database (2010).

The survey was distributed to the selected participants via an e-mail containing a link to the survey. The e-mail introduced the survey by describing the study and the benefits of participation. Once the link was followed, the participants were directed to the survey's cover letter. This letter stated the purpose of the study, as well as provided confidentiality information and instructions on how to proceed. As an additional incentive, the BCCDC has supplied five $10 Tim Horton's gift cards as prizes. All participants who provided their contact information were eligible, and the winners were selected based on a random draw.

To remind participants who had not completed the survey, a follow up e-mail was sent approximately two weeks later. In order to achieve a more accurate statistical analysis, a minimum number of thirty responses had to be collected. In order to achieve a higher number of responses, some establishments were also contacted by telephone. The survey was conducted over the telephone by verbally reading the questions and having the researcher input the data for the participant.

Reliability and Validity of Measures

In order for a study to achieve optimal results, the utilized instrument must be high in both validity and reliability. In the case of this study, the instrument utilized was the questionnaire itself. There are a variety of techniques that can be utilized in order to increase both the validity and reliability of a study. Some methods applicable to this survey were to administer the questionnaire in a consistent fashion and to conduct a pilot test.

Inclusion and Exclusion Criteria

The inclusion criteria for participants who were involved in the study were that they must be a food retail premises located in the Province of British Columbia. In addition, these premises must purchase raw cuts of beef, process, and then sell this meat directly to the consumer. These sales are either intended for immediate consumption, as in a restaurant, or for further preparation and consumption by the consumer at a later date. These establishments include but are not limited to grocery stores, butcher shops, restaurants that serve meat products, and direct to retail meat processing facilities

On the other hand, food premises were excluded if they do not buy raw beef products, they do not sell beef products, or if they sell their products to another processor or business and not directly to consumers. For example vegetarian or vegan restaurants, corner stores who sell pre-packaged goods, and premises which do not sell directly to the consumer.

Ethical Considerations

For this survey, informed consent, anonymity, confidentiality, and the right to privacy and knowledge of the individuals involved were taken into account. The British Columbia Institute of Technology Guidelines for Ethical Review of Activities involving Human Subjects (2013) recognizes that human participants have a right to privacy and the identity of participants should be kept confidential. In addition, the guidelines state that participants should be assured as such via a consent form. In order to maintain a high level of ethical conduct, this survey included a cover letter which provided a statement of confidentiality and consent.

Pilot Studies

A pilot study was conducted for this survey through third party assessments. To achieve this, the content and structure of the survey questions were evaluated from an objective point of view from individuals with related backgrounds. Lorraine McIntyre, a food safety specialist, and Maria Peters, a meat safety specialist from the British Columbia Centre for Disease Control reviewed the survey and provided the researcher with appropriate feedback. In addition, Chris Russell, an Environmental Health Officer with Interior Health reviewed the survey, as well as Directors from both the BC Small Scale Food Processors Association and the BC Food Processors Association. Using their criticism, the survey questions were adjusted appropriately to achieve more valid and reliable results.

Statistical Analysis

Description of the Data

The data that was collected in this survey consisted of responses from a variety of multiple choice questions that consisted of both nominal and ordinal scales. Table 2 lists some examples of question types that are present in the survey.

Nominal Dichotomous	Nominal Monochotomous	Ordinal
Yes/No	Restaurant, butcher shop, grocery store	Level of experience
	Blade, needle, mallet, other	Number of staff

Table 2: Sample of Survey Data

Statistical Package

Microsoft Excel was used to record and keep track of the data, and the statistical program used to analyze the data was NCSS Statistical Software (2012). This software provided a comprehensive package that allowed for effective data analysis.

Descriptive Statistics

The type of data gathered in this survey is best represented by descriptive statistics. Each question can be summarized and presented in a variety of charts and graphs. In addition to visual representations, the data can also be shown as proportions or percentages of observations.

Inferential Statistics

The chi-square statistical test was used to analyze the results of the survey. This test was chosen because it is able to analyze nominal data (Heacock & Sidhu, 2013). This test compares frequencies or proportions in two or more groups, and determines if there is an association present.

Results

The total number of establishments to respond to the survey was 34, and the percentage of each establishment type response can be viewed in figure 2. The descriptive results for each question in the survey are displayed in bar graphs and pie charts.

Interpretation of Results

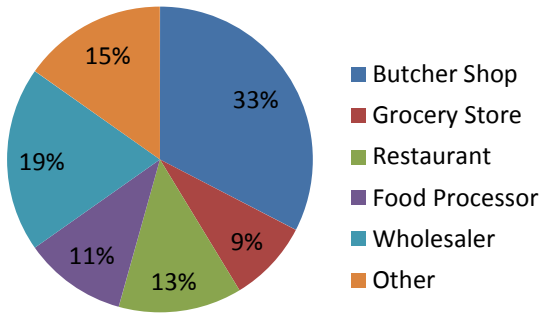


Figure 2: Response by Establishment Type

The proportion of establishments who stated that they mechanically tenderize at their premise was eight out of thirty four respondents, or 24%. Of the establishments who mechanically tenderized their meat, all used either blade or needle tenderization. However, only 33% of these establishments identified that their meat had been mechanically tenderized on a label, and 17% provided adequate cooking instructions on this label.

Statistical Test 1: Chi- square of Operator Experience compared to Level of Knowledge

Ho: there is no association between operator experience and level of knowledge

Ha: There is an association between operator experience and level of knowledge

P = 0.20235, therefore, Ho cannot be rejected, and it is concluded that there is no association between operator experience and level of knowledge

Statistical Test 2: Chi- square of Mechanical Tenderization compared to Establishment Type

Ho: there is no association between mechanically tenderizing meat and establishment type

Ha: There is an association between mechanically tenderizing meat and establishment type

P = 0.00338, therefore, Ho can be rejected, and it is concluded that there is an association between mechanically tenderizing meat and establishment type

Discussion

Although the survey was distributed electronically to all establishment types, certain types were more likely to respond than others. There was a particular lack of response from chain grocery stores when attempting to contact the head office through e-mail. Therefore, grocery stores had to be telephoned and the researcher had to speak directly with the meat department in order to acquire survey responses. On the other hand, the majority of responses came from butcher shops, at 33% of total responses. In addition, the majority of responses were from participants located in Greater Vancouver, as can be seen in figure 3. This may be because Greater Vancouver businesses rely more on e-mail and the internet, therefore it is more likely that the owners would complete the survey.

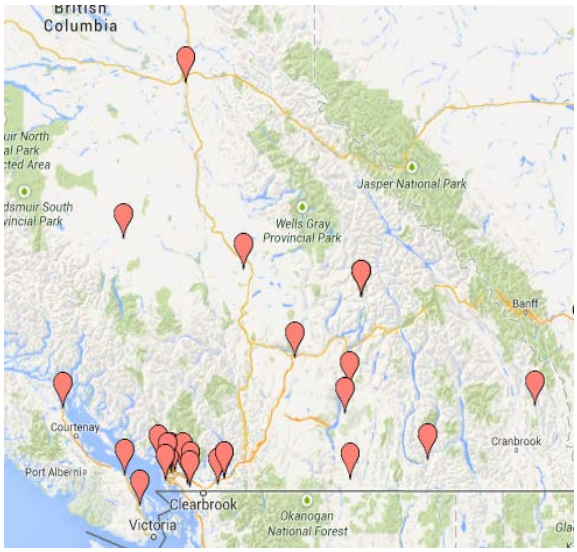


Figure 3: Location of Surveyed Establishments

Since the XL foods outbreak in 2012 and the recognition of mechanical tenderization as a health risk, there has been an increase in awareness of the concerns of this process from health professionals and industry alike. The results of this survey demonstrate a current high level of industry operator awareness through an 88% "yes" response when asked if they were aware of the XL outbreak. In addition, 91% of operators responded that they were somewhat to very knowledgeable about the concerns of mechanically tenderized beef. Operator awareness regarding the concerns of mechanically tenderized meat is critical in their understanding of the potential negative health consequences. With this knowledge, operators can work to prevent further health issues by implementing greater monitoring and control measures in their practices. However, although there was a high level of overall operator knowledge, no association was observed between the number of years an operator had been working in the food industry and their level of knowledge regarding mechanical tenderization. This may be because education was increased throughout the entire industry due to the large amount of media coverage and consumer outrage caused by the XL foods outbreak, and is not specific to experience.

Contamination has been a major concern in the meat industry for decades, and concerns have been increasing with the multitude of processing techniques. In order to protect the public, there are a variety of control measures that can be undertaken to prevent mechanically tenderized meat from being linked to cases of foodborne illness. Firstly, care can be taken to prevent contamination via the utilization of proper cleaning and sanitation techniques. This study shows that the sanitation plan of 100% of surveyed establishment who mechanically tenderize includes a complete cleaning and sanitation at the end of each day. Also, 45% of these establishments clean and sanitize between batches of meat. Proper cleaning and sanitation of the tenderization equipment can help prevent cross contamination between pieces of meat, reducing the amount of contaminated meat. Although it is acceptable that the equipment is cleaned thoroughly each evening, cleaning and sanitizing between batches is a practice that could better prevent against further contamination.

Another control measure that can help reduce foodborne illness is education of the consumer on the risks of mechanically tenderized meat, and how to protect themselves by using proper cooking and handling techniques. One method that can be used to communicate this risk is implementing labeling on packaging. This survey shows that of establishments who either buy mechanically tenderized meat or perform in-house mechanical tenderization, 33% have a label on their packaging that states the meat has been processed in this manner. However, only 17% have the proper cooking

and handling instructions on the label. Having a label can educate customers by providing the correct internal temperature that must be reached in order to ensure the destruction of any pathogenic organisms that may be present. This way, the customer is well-informed of the risk, and has the ability to protect themselves by properly cooking this meat.

Looking at previous research, the Public Health Agency of Canada speculates that the percentage of meat that has been mechanically tenderized in Canada could be between 20 to 50 percent (VCH, 2013). Although this study did not look at weights and quantities, the results confirm that 26% of surveyed establishments report purchasing beef that has been mechanically tenderized or utilizing in-house mechanical tenderization themselves. In addition, all large chain grocery store establishments surveyed reported they performed mechanical tenderization on some of their beef products. In fact, an association was observed between establishment type and the use of mechanical tenderization, which suggests that certain establishments, such as grocery stores, are more likely to mechanically tenderize than others, such as restaurants. Perhaps this association is due to the size of meat processing operation and quantity of meat products located at a grocery store in comparison to a restaurant. Overall, the likelihood is high that consumers purchase and consume beef at some point that has been mechanically tenderized at the retail level.

Limitations

Although this study was able to provide some baseline results of establishments that mechanically tenderize their meat, there are several areas of weakness that could have been conducted more effectively or improved upon. These areas of weakness include having a relatively small sample size in addition to limited numbers of certain establishment types. Also, there were limitations of asking certain question types. Increasing the quantity of certain establishment types such as grocery stores and restaurants, as well as the overall sample size would help to yield more valid and reliable data.

Even though the survey was sent out to a large number of potential participants, only 34 responses were gathered. Conducting the survey primarily by telephone would have likely increased sample size, as establishments were more likely to respond when contacted this way; however this method also has the potential for interviewer bias. In addition, enlisting the aid of further associations would have been beneficial in increasing the amount of establishment types surveyed. For example, enlisting the help of the BC Restaurant and Foodservices Association would have increased the amount of restaurants surveyed by distributing the survey to their members through newsletters or e-mail.

Finally, in addition to sample size, there was some weakness in regards to the content of certain questions. For example, asking the participant to self-identify their own level of knowledge allows for individual bias of the question taker. For instance, they may observe themselves to be more or less educated than they are in actuality. To correct this, more knowledge based questions could be asked. Also, certain questions may have been more effective if phrased as an open ended question rather than multiple-choice. For example, asking the operator to describe their individual sanitation practices in words would have provided a more descriptive response that choosing from a set list.

Conclusions

Although a variety of questions were asked in this survey, all of the responses can help to shed light on the extent to which mechanical tenderization is occurring along with current industry practices. Having an understanding of practices such as where meat is coming from, the subsequent food handling, labeling, and sanitation practices, as well as the operator's level of knowledge and experience are all essential in assessing the potential risk to consumers.

Recommendations

The information gained through this study can be used to aid public health officials in quantifying the risk of mechanical tenderization at the retail level, as well as provide further details such as current industry labeling practices. Currently, Health Canada is proposing amendments to the Food and Drug Regulation that would require mandatory labeling for Mechanically Tenderized Beef (Regulations Amending the Food and Drug Regulations, 2014). This proposal would extend to include all retail establishments utilizing or selling mechanically tenderized beef. Therefore, the results of the labeling aspect of this survey could be used to determine the extent to which labeling of this product is currently being performed at the retail level, thereby determining the proportion of establishments that may need to be educated or provided with guidance on the new requirements.

Future Research Suggestions

Suggestions for further research include repeating the study at a larger scale and creating a secondary

survey to monitor operator understanding of the new labeling practices. Firstly, to achieve more valid and reliable results, a larger scale study could be performed to determine the proportion of establishments who mechanically tenderize and gain further information regarding their food safety and labeling practices, including asking knowledge based questions to more accurately assess operator understanding. In addition, after new labeling legislation is enacted, a further survey could be conducted to test the understanding and compliance of the newly implemented mandatory labeling.

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Competing Interests

The author declares that they have no competing interests.

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