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July 25, 2005

FSIS Docket Clerk
Docket No. 04 – 042N
U.S. Department of Agriculture
Food Safety and Inspection Service
Room 102, Cotton Annex Building
300 12th Street SW
Washington, DC 20250-3700

Re: Docket No. 04 – 042N "HACCP Plan Reassessment for Mechanically Tenderized Beef Products"

Dear Docket Clerk:

On behalf of the National Cattlemen's Beef Association (NCBA) I want to express our appreciation for the opportunity to comment on the Food Safety and Inspection Service (FSIS) Docket No. 04 – 042N "HACCP Plan Reassessment for Mechanically Tenderized Beef Products." Producer-directed and consumer-focused, NCBA is the trade association of America's cattle farmers and ranchers and the marketing organization for the largest segment of the nation's food and fiber industry.

Beef safety is a top priority for NCBA and the beef industry. We are committed to working with the entire beef production chain as well as state and federal governments to further decrease the incidence of *E. coli* O157:H7. Multiple interventions at all points in the production process are critical in working to control and reduce the threat of this pathogen. Individual sectors of the beef industry can not function autonomously in this endeavor; all sectors of the industry must work together with the government and consumers. By utilizing the best available science and a unified approach, we can work to control and reduce the incidence of *E. coli* O157:H7.

Since 1993, through the beef checkoff program, beef producers have invested more than $24 million in beef safety research and development of methods to control, test for and sample *E. coli* O157:H7. Significant progress has been made by decisions based on the sound scientific discoveries of all available research, not just that funded by the checkoff. As research continues to identify new and useful technologies, collaboration between the Food and Drug Administration (FDA), FSIS and the beef industry is needed to ensure the timely implementation of the best interventions throughout the beef production chain. Consistent with our vision of a unified team effort to address these issues, we have provided comments on the Notice below for the agency to consider as they move forward in an effort to improve the food safety system.

Comments

NCBA believes processing establishments should make an ardent effort to minimize the threat of *E. coli* O157:H7 by continually reviewing current research to strengthen the evaluation of their HACCP procedures. As part of that effort, NCBA would encourage establishments producing non-intact, mechanically tenderized or enhanced products to reference the Beef Industry Food Safety Council (BIFSCo) Best Practices for "Pathogen Control During Tenderizing/Enhancing of Whole Muscle Cuts" (see most recent version at http://www.bifsco.org/BestPractices.aspx), which the FSIS referenced in this Notice. These BIFSCo Best Practice guidelines are designed to provide establishments producing tenderized or enhanced products with scientifically supported recommendations to reduce the likelihood of contamination with a potential pathogen. NCBA is also submitting a white paper, "Food Safety Risk Associated with Non-Intact Tenderized Beef Products," as another source of scientific information on this issue. Utilizing the information presented in both of these documents, NCBA has specifically addressed the following items mentioned by FSIS within the Notice:

- In requesting that establishments reevaluate their HACCP plans with regard to the most recent outbreaks (June 2003 and August 2004), FSIS asks that mechanically tenderized products, whether they are enhanced with marinade or not, be considered in the same manner.
    - The BIFSCo document clearly demarcates specific Best Practices for Needle Tenderizing, Brine-Injecting (enhancing) and Suspension Injecting. These separate categories are established because of the "unique differences between the processes."
    - By grouping tenderized and enhanced products together FSIS ignores the "unique differences" between the products.
    - NCBA recognizes the importance of establishments implementing effective HACCP protocol, and we believe that well founded procedures should recognize tenderized and enhanced products independently.

- FSIS recommended that establishments carefully review their purchasing specifications for incoming products to ensure the beef they are receiving has been through a validated intervention for *E. coli* O157:H7.
    - The BIFSCo Best Practices begin with optimizing raw material quality and safety. Establishments producing tenderized or enhanced products should require raw material suppliers to have validated process intervention and/or validated critical control points (CCPs) in place to control, reduce or eliminate *E. coli* O157:H7.
    - It is also important for non-intact production establishments to have specific data on *E. coli* O157:H7 incidence, thus plants should utilize published data that has been collected through subprimal sampling surveys.

- FSIS asked that establishments producing tenderized or enhanced products evaluate the adequacy of their sanitation operating procedures (SOPs) for mechanical tenderizers and associated processing equipment.

- The BIFSCo Best Practices delineate specific examples of effective cleaning and sanitation guidelines and each establishment should especially focus on areas such as equipment break-down and zone cleaning.
- There is scientific evidence to suggest that *E. coli* O157:H7 should not be considered a hazard reasonably likely to occur on whole muscle cuts, including those destined for tenderizing or enhancing operations. Included in the white paper are studies conducted by ABC Research Corporation and Food Safety Net Services, Ltd. on the prevalence of *E. coli* O157:H7 on the surface of beef subprimals. With only two of 2,213 subprimals examined in the three surveys positive for *E. coli* O157:H7, these studies indicate that contamination of mechanically tenderized cuts with this pathogen is "unlikely" (Food Safety Net Services, Ltd. study conclusion) and would be an "improbable phenomenon" (ABC Research Corporation conclusion).
- The ABC Research Corporation study sampled 1199 subprimal cuts, all destined for mechanical tenderization, and found no incidence of *E. coli* O157:H7.
- With this information in mind, NCBA believes that cleaning and sanitation procedures are the most effective manner in which the threat of *E. coli* O157:H7 can be even further reduced.

- FSIS suggested that establishments producing raw, mechanically tenderized beef products might also consider including cooking instructions on their products, though these cooking instructions could not serve as a CCP to address *E. coli* O157:H7.
  - Food Safety Net Services, Ltd. evaluated the effectiveness of cooking procedures on ten different commercial beef products (see page 7 of attached white paper). All products tested were labeled with "Safe Handling Instructions" including "Cook Thoroughly" as required by USDA – FSIS. Results of the study suggest that the meat industry should provide adequate cooking instructions on all raw beef products, including both intact and non-intact whole muscle cuts. On the foundation of the Food Safety Net Services, Ltd. study, NCBA supports FSIS recommendation that establishments consider placing cooking instructions on their product, but we would point out that there is no scientific evidence to support differentiating between intact and non-intact products with regard to the inclusion of cooking instructions on the product.

- FSIS points to potentially requiring that raw, mechanically tenderized products be labeled to indicate they have undergone mechanical tenderization.
  - Included on page four of the attached white paper is a Kansas State University study conducted to determine the degree of translocation of *E. coli* O157:H7 to the interior muscle tissue of a steak during a single pass through a blade tenderizer. It was shown that only 3-4% of the pathogen on the surface was translocated to the interior of the muscle.
  - Another Kansas State University study, included on page five of the white paper, was conducted to evaluate the effectiveness of cooking procedures on the destruction of *E. coli* O157:H7 in intact and mechanically tenderized beefsteaks. The 2001 Food and Drug Administration (FDA) Food Code does not include heating temperatures below 130°F for raw animal products, and when cooked to

130°F there was no significant difference in the *E. coli* O157:H7 reduction between tenderized and non-tenderized steaks, at 5.6 log and 5.0 log respectively. At endpoint temperatures of 140°F, 150°F, 160°F and 170°F there was an equal 6-log reduction of *E. coli* O157:H7 in both tenderized and non-tenderized steaks. The study concluded that cooking to at least 140°F provides the necessary thermal destruction required to eliminate the public health risk from *E. coli* O157:H7 in both tenderized and non-tenderized steaks.

- Also included on page nine of the white paper is a survey conducted by Kansas State University, in conjunction with the North American Meat Processors, that determined 82% of consumers surveyed cook their beef products above 145°F to a level of doneness of medium or above.
- As previously mentioned, NCBA recognizes the Food Safety Net Services, Ltd. recommendation that all raw meat products be labeled with cooking instructions to inform consumers of the need to adequately heat beef products. But, with a majority (82%) of consumers already cooking their beef products to a temperature of 145°F or above, and scientific evidence that at those temperatures tenderized beefsteaks pose no greater threat to public health than non-tenderized, NCBA sees no basis for discriminately labeling mechanically tenderized products.

- FSIS encouraged establishments producing mechanically tenderized beef products to consider applying an allowed antimicrobial agent to the surface of the product prior to processing.
  - Antimicrobial interventions and inhibitors applicable to tenderizing or enhancing operations continue to be developed and should be considered a useful tool at the establishment's disposal for controlling or reducing *E. coli* O157:H7.
  - Establishments can also utilize "processing aids" which need not be listed as ingredients on enhanced products.

Conclusion

NCBA believes that while continued efforts to ensure the control and reduction of *E. coli* O157:H7 are prudent, the incidence of *E. coli* O157:H7 on the surface of subprimals is rare. Scientific studies lead NCBA to conclude that *E. coli* O157:H7 is not a hazard reasonably likely to occur. For that reason, we believe that when conducting their HACCP reassessment, establishments should carefully and independently consider their Sanitation SOPs for tenderized and enhanced beef products. Furthermore, in the unlikely event of contamination of a subprimal by *E. coli* O157:H7, translocation from the surface of subprimals into the subsurface muscle tissue during mechanical tenderization occurs at low levels. Even with transmission to the interior of the product, cooking studies confirmed that non-intact beefsteaks and roasts provide no more significant food safety hazard than intact products when heated to an endpoint temperature of at least 140°F, and 82% of consumers already cook their beef products to an internal temperature of at least 145°F. NCBA supports the FSIS continued efforts to advance food safety and protect public health but does not agree with broadly defining both tenderized and enhanced products as "mechanically tenderized products." Moreover, we do not see sufficient scientific evidence at this time to support a requirement of beef establishments that they discriminately label mechanically tenderized beef products as non-intact.

NCBA appreciates the opportunity to provide comments on this important issue. The beef industry is committed to providing a safe, high quality product to our consumers and the entire industry must work together with the government to further improve our food safety system. We look forward to continuing to work with the government on challenging issues so that solutions may be reached which benefit public health.

Sincerely,

Leah Wilkinson

Leah Wilkinson
Director, Food Policy

FOOD SAFETY RISK ASSOCIATED WITH NON-INTACT TENDERIZED BEEF PRODUCTS

A Summary of Beef Checkoff-Funded Research

FOOD SAFETY RISK ASSOCIATED WITH NON-INTACT TENDERIZED BEEF PRODUCTS

ABSTRACT

As the representative of the U.S. beef industry, the National Cattleman's Beef Association (NCBA) has been proactive in addressing the potential public health concern of *E. coli* O157:H7, *Salmonella* and *Listeria monocytogenes* in mechanical tenderized, needle injected or restored beef products. This paper is a summary of several research studies funded by the beef checkoff. Three surveys of 2,213 intact beef subprimals showed that the incidence of *E. coli* O157:H7 was very low. This pathogen was isolated from only two samples and the quantitative count was <3.0 CFU per 200 cm^2. After inoculating the surface of subprimals with *E. coli* O157:H7, it was demonstrated that mechanical tenderization transposed a low level of the pathogen to subsurface muscle tissue. However, there is no public health risk if the consumer cooks steaks and roasts to an endpoint temperature of at least 140°F. The effect of different intervention treatments on the survival of *E. coli* O157:H7 on subprimal beef products was also studied. Acidified sodium chlorate (ASC) or peroxyacetic acid (PAA) were added to the surface of subprimals inoculated with *E. coli* O157:H7 as intervention treatments prior to mechanical tenderization. Both chemical treatments caused a significant reduction in the level of *E. coli* O157:H7 on the surface but not in the subsurface muscle tissue. A combination of a hot (170°F) lactic acid dip for 2 to 4 seconds followed by a 60 to 70 microwave treatment after packaging resulted in a 1.0 to 1.5 log reduction in the number of *E. coli* O157:H7 on 5.0 lb beef blocks.

Checkoff funded studies were conducted to determine if *Salmonella* or *Listeria monocytogenes* on beef subprimals presented a public health risk. Neither pathogen grew in inoculated tenderized steaks during storage at 45°F for 21 days. It was concluded that *Salmonella* and *L. monocytogenes* did not present a public health risk if steaks and roasts are cooked to at least 140° F.

INTRODUCTION

E. coli O157:H7 was first recognized as a foodborne pathogen in 1982 when it was associated with illness in people that had consumed contaminated undercooked ground beef. It is estimated that 62,000 cases of *E.coli* O157:H7 infection occur yearly in the US. In 1994 the USDA/ FSIS notified the public that raw ground beef contaminated with *E. coli* O157:H7 would be considered to be adulterated under the Federal Meat Inspection Act unless the ground beef is

further processed to destroy the pathogen. In 1994, the FSIS began testing ground beef for *E. coli* O157:H7.

In January 1999 the USDA/FSIS published a notice in the Federal Register that that expanded their *E. coli* O157:H7 adulteration policy to include non-intact beef products. Beef products that were affected by this new policy were (a) beef primal or subprimal cuts that are blade or needle tenderized, (b) those that are injected with chemicals, and (c) steaks and roasts made by combining pieces of beef through restructuring. The concern is that the mechanical tenderization or needle injection procedures will contaminate subsurface muscle tissue with *E. coli* O157: H7 and therefore a higher cook temperature would be required to render the product safe for human consumption. The new policy states that any non-intact beef product found to be contaminated with *E. coli* O157:H7 would be considered to be adulterated and therefore must be processed into a ready-to-eat product.

It is a common practice to subject beef subprimals to a tenderization procedure to improve tenderness. The subprimals are penetrated with double edge blades or needles and the subprimals arethen cut into individual steaks or roasts.

In 2001, the National Advisory Committee on Microbiological Criteria for Foods (NACMCF) was asked by USDA/FSIS to address several questions with the regard to the potential public health risk by the presence of *E. coli* O157:H7 in tenderized, non-intact beef steaks and roasts. In their final report published in 2002, NACMCF concluded that non-intact blade tenderized beef steaks do not present a greater risk to consumers if the meat is oven broiled and cooked to an internal temperature of 140°F or above (10). Although the data were more variable at temperatures below 140°F, it was still possible to achieve a 3.2 log reduction of *E. coli* O157:H7 for tenderized beefsteaks. The NACMCF concluded that additional research was needed to determine whether non-intact tenderized beef roasts present a greater risk to consumers from *E. coli* O157:H7 when prepared in the same way as intact roasts.

Since 1999, the NCBA has managed a series of checkoff funded research projects to determine the potential public health risk associated with *E. coli* O157:H7, *Salmonella* and *L. monocytogenes* in tenderized beef subprimals. The results from these research studies are summarized in this paper.

Summary of Beef Checkoff-Funded Research Projects

Prevalence Surveys

Three independent studies were conducted to determine the prevalence of *E. coli* O157:H7 on the surface of beef subprimals. The first study, conducted by the ABC Research Corporation, was designed to determine the prevalence of *E. coli* O157:H7 and indicator organisms on the surface of 200 samples of each of the following six beef subprimals: chuck tenders, trimmed strips, bottom round flats, trimmed brisket, cap-on top rounds and cap-off inside rounds (5). 1200 sub-primal beef products from 5 plants were examined prior to mechanical tenderization for *E. coli* O157:H7, total aerobic plate count, coliforms and generic *E. coli*.

E. coli O157:H7 was not detected in any of the 1200 beef samples tested. The aerobic plate counts, total colforms and generic *E. coli* counts from the 600 samples were variable within each sample set of each sub-primal and between the six sub-primal types. The levels of generic *E. coli* were either very low or undetectable for most of the subprimal samples. It was concluded fom these results that internal contamination of beef subprimals with *E. coli* O157:H7 by mechanical tenderization is an improbable phenomenon.

Food Safety Net Services, Ltd. and Colorado State University conducted a similar study of subprimal beef cuts prior to mechanical tenderization for the presence of *E. coli* O157:H7 (13). The surface of 1,014 beef samples from 6 processing plants during the months of June and July were examined. Only two of the subprimal beef samples tested positive for *E. coli* O157:H7 and the quantitative count of the two positive samples was <3.0 CFU per 200 cm^2. The results from this study indicate that *E. coli* O157:H7 is not a common contaminant on the surface of subprimal beef cuts prior to mechanical tenderization. It was concluded that internal contamination of sub-primal beef cuts by this pathogen via mechanical tenderization is unlikely to occur.

Translocation Studies

Kansas State University conducted a study to determine the degree of translocation of *E. coli* O157:H7 to the interior muscle tissue of a steak during tenderization (8). The results from the first study showed that after a single pass through a blade tenderizer, 3-4% of *E. coli* O157:H7 on the surface was translocated to the interior muscle tissue.

Checkoff dollars were also used to fund a study to determine the potential public health risk associated with the presence of either *Salmonella* or *Listeria monocytogenes* present on the surface of subprimals. Silliker Laboratories conducted a study to determine the frequency and distribution of pathogenic and non-pathogenic bacteria on the surface and in the core of non-intact beef products throughout the US (3). The pathogens were *L. monocytogenes*, *Salmonella*, *E. coli* O157:H7, *Campylobacter jejuni/coli*, *Clostridium perfringenes*, and coagulase positive *Staphylococcus aureus*. The non-pathogenic bacteria included in this survey were aerobic plate count, generic *E. coli* and coliform. A total of 49 cubed steaks, 30 rolled roasts, 28 corned beef, 12 pumped roasts and

25 needle-tenderized steaks were included in this study. The samples were obtained from retail food stores and food service sources. Individual 25-gram samples were used for quantitative and qualitative analysis.

L. monocytogenes was isolated from 100% of the needle-tenderized steaks and from 7% of the other products. The distribution of the *L. monocytogenes* between the interior and exterior samples was equal. The average number of *L. monocytogenes* from the exterior and core of the different beef products was 0.68 and 0.45 MPN/g respectively. These values are not significantly different.

The single isolation of *Salmonella* was from the surface of a rolled roast. *E. coli* O157:H7 and *Campylobacter* were not present in or on any of the analyzed beef products. The aerobic plate count, coliform count and generic *E. coli* count were higher on the surface of products than in the core. The average counts of *S. aureus* and *C. perfringenes* were <11 CFU/g.

Cooking Studies

Kansas State University researchers conducted a study to evaluate the effectiveness of cooking procedures on the destruction of *E. coli* O157:H7 in intact and mechanically tenderized beef steaks (8).

This heating study was designed to determine the thermal destruction of *E. coli* O157:H7 in tenderized steaks during broiler cooking to different endpoint temperatures. The surface of top sirloin subprimals was inoculated with 10^7 CFU/cm^2 *E. coli* O157:H7 prior to being tenderized in a blade tenderizer. The steaks, cut from the tenderized inoculated subprimals, were broiled to endpoint temperatures of 120°F, 130°F, 140°F, 150°F, 160°F and 170°F. After they reached the designated endpoint temperature, the steaks were immersed in an ice bath to quickly halt the heating process. Steaks cut from inoculated sub-primals that were not tenderized were used as controls.

Initial statistical analysis of all main effects (treatment, weights, and temperature) and all possible combinations of interaction, with bacterial reduction as the dependent variable, revealed a significant ($p \leq 0.05$) interaction between the treatment (tenderized and non-tenderized) and temperature. Heating tenderized steaks and non-tenderized steaks to 120°F resulted in a significant ($p \leq 0.05$) difference in the destruction of *E. coli* O157:H7. The results showed a 3.2 log reduction and a 5.2 log reduction in tenderized and non-tenderized steaks respectively. While the endpoint temperature of 120°F was sufficient to destroy 5 logs of *E. coli* O157:H7 on the surface of non-tenderized sub-primals, it was not high enough to eliminate the pathogen in the interior of tenderized steaks. It should be noted that the 2001 FDA Food Code does not include heating times and temperatures below 130°F for raw animal products (12).

At 130°F the log reduction of *E. coli* O157:H7 for the tenderized and non-tenderized steaks was 5.6 and 5.0 respectively. This difference was not significant.

At endpoint temperatures of 140°F, 150°F, 160°F, and 170°F, there was a 6-log reduction in both the tenderized and non-tenderized steaks. It was concluded that a target temperature of at least 140°F provides the necessary thermal destruction required to eliminate the public health risk from *E. coli* O157:H7.

It was noted in this study that even though the steaks were rapidly chilled in ice water after broiling to a specific endpoint temperature, the internal temperature continued to rise by approximately 11°F. This is an important margin of safety for broiled steaks being served in a food service setting.

ARS scientists conducted a study to determine the effectiveness of six grilling temperatures for destroying *E. coli* O157:H7 in steaks cut from inoculated subprimals (8). In this study, sub-primals were inoculated on the lean side of subprimals with 10^6 CFU/cm^2 and passed once through a mechanical tenderizer. After tenderizing, the sub-primals were cut into steaks that were 0.75, 1.0, and 1.25 inches thick. The streaks were grilled to internal temperatures of 120°F, 130 °F, 140 °F, 150 °F, 160 °F and 170°F. Five core samples from predetermined locations, were aseptically removed from each steak and tested for surviving *E. coli* O157:H7.

The results from the grilling study showed the following:

1. Greater lethality was observed as the target cooking temperature increased.
2. With the exception of 130°F, greater lethality was observed as the thickness of the steaks increased.
3. In some instances greater lethality was observed for two core samples than in the other three core samples.
4. *E. coli* O157:H7 was recovered with direct plating methods from steaks cooked to 120°F and 140°F, whereas the pathogen was only recovered by enrichment from some of the steaks that were cooked at 150°F and from all the steaks cooked to160°F and 170°F.

Silliker Laboratories personnel conducted a study in which cubedsteaks, rolled roasts, corned beef, pumped roasts and needletenderized steaks were inoculated with a five strain cocktail of *Salmonella*, *L. monocytogenes* and *E. coli* O157:H7 and then heated to temperatures ranging from 145°F to 160°F (4). A syringe was used to inoculate these same five beef products in the center to a level of 10^7 cells per gram. Four cooking procedures were used. The cubed steaks were pan-fried and the corned beef was water cooked. The needle tenderized steaks and pumped steaks were oven broiled. Rolled roasts were cooked in an electric convection oven. All five products were cooked to end point temperatures of 145°F, 150F°, 155°F and 160°F.

Non-cooked inoculated beef samples were used as controls to establish the initial inoculum levels. Non-cooked, non-inoculated samples were analyzed to demonstrate the methods to differentiate the pathogenic test organisms from the non-pathogenic background microflora of the samples.

In this study, there was no effort to rapidly chill the five beef products after heating and the internal temperature continued to rise after they reached their target internal temperature. This temperature increase ranged from 3°F for pan-fried steaks to 10°F for the broiled tenderized steaks, which added to the cooking period.

The rate of inactivation of the three pathogens varied with product type and pathogen type. Pathogen reduction in the five beef products cooked to 145F varied greatly by product and to a lesser degree with pathogen type. The reductions ranged from 1.1 to 5.3 logs.

In fully cooked product (160°F) the log reduction of the pathogenic bacteria ranged from 2.5 to 6.6 logs. The level of pathogen reduction at 150°F and 155°F was between those observed for 145°F and 160°F. In general, the lowest reductions were in pan-fried cubed steak and the highest in water cooked corned beef.

The visual cooked appearance of the five beef products cooked to the 4 different temperatures was documented in this study. When cooked to an endpoint temperature of 145°F, all five products had a lightly browned surface color and a rare "bloody" internal appearance. When the products were heated to the 160°F endpoint temperature, the outer surface was described as dark brown and with the exception of the needle tenderizedsteak, the core was still slightly pink and juicy. The core of the tenderized steak was considered to be well done, but juicy.

Food Safety Net Services, Ltd. evaluated the effectiveness of cooking procedures, on ten different commercial beef products (1). This study included two whole muscle products, loin steak and top sirloin. While all of the beef products were labeled with the "Safe Handling Instructions" including "Cook Thoroughly" as required by USDA, FSIS, only one included recommended cooking instructions.

Three vendors produced the loin steak and top sirloin. The loin steak and top sirloin from vendors #1 and #2 were not mechanically tenderized. Vendor #3 mechanically tenderized both products. Vender #1 was the only one to include cooking instructions for grilling and pan-frying. When the grilling and pan-frying instructions were followed, the final internal temperatures for the loin steak and top sirloin ranged from 148°F to 155°F. In the food service industry, this is considered to be medium rare.

When the grilling and pan frying cooking instructions from vendor #1 were followed for preparing the loin steak and top sirloin from vendors # 2 and #3, the final internal temperature ranged from 147°F to 160°F. The NACMCF report concluded that intact or tenderized steaks cooked to an internal temperature of at least 140°F do not present a public health risk in relation to *E. coli* O157:H7 (10).

Based on the results from this study, it was suggested that the meat industry should provide adequate cooking instructions on all raw beef products, including intact and tenderized whole muscle products. The cooking instructions should include at least two cooking methods.

The ABC Research Corporation conducted a study to determine the fate of *Salmonella* and *L. monocytogenes* in mechanically tenderized beef products (6). After inoculating the surface of top butt subprimals with a low and high level(list the levels) of either pathogen, the subprimals were passed twice through a commercial blade tenderizer. The subprimals were then cut into steaks and vacuum packaged and stored at 0°F, 28°F and 45°F. After 0, 3, 7, 14 and 21 days storage, triplicate samples were tested for microbial growthby direct plating and the more sensitive ELISA assay. For each inoculumlevel, a total of 45 steak samples were examined for all storage times and temperatures.

Steaks from subprimals inoculated with a high level of*L. monocytogenes* had a mean inoculum level of 7,440 CFU/g. The count in steaks inoculated with the low inoculum level ranged from below the detection level to 10 CFU/g by direct plating. Steaks made from subprimals inoculated with a high and low level of *Salmonella* had a mean inoculum level of 390 CFU/g and below the detection level to 10 CFU/g, respectively.

The inoculated steaks were heated on a flat top grill on both sides to an internal temperature of 125°F, 135°F, 145°F, 155°F and 165°F to represent rare, medium rare, medium, medium well and well-done steaks. The cooked steaks were cooled at ambient temperature to 110°F or less to simulate actual food service preparation before they were tested microbiologically.

Neither *L. monocytogenes* nor *Salmonella* grew in the tenderized steaks during storage at 28°F or 45°F for 21 days. The numbers of both pathogens gradually decreased. It is speculated that the growth of the background microflora duringstorage at these temperatures may have caused the decrease in the numbers of *Salmonella* and *L. monocytogenes*.

Regardless of storage time and temperature, increasing theinternal endpoint temperature of steaks during cooking resulted in a greater reductions in *L. monocytogenes* and *Salmonella*. At the high inoculum level, both pathogens were recovered by direct plating or with the ELISA assay at each endpoint temperature.

At the low inoculum level, *L. monocytogenes* was recovered from 6 of 45 samples, 4 of 45 samples and 2 of 45 samples cooked to an internal temperature of 125°F, 135°F and 145°F, respectively. *L. monocytogenes* was not recovered from the 45 samples cooked to 155°F or 165°F.

At the low inoculum level, *Salmonella* was recovered from 3 of 45 samples, 2 of 45 samples and 4 of 45 samples when the steaks were cooked to 125°F, 135°F, or 145°F respectively. None of the 45 samples cooked to 155°F tested positive for *Salmonella* and one of 45 samples cooked to 165°F tested positive.

The North American Meat Processors and Kansa State University conducted a survey to determine the cooking practices and methods for beef steaks and roasts (11). Five hundred individualswere surveyed on their cooking practices and methods for preparing steaks and roasts. The results of the survey showed that most participants used color as an indicator of doneness of steaks and cooking time was used for roasts. While none of the individuals surveyed knew that 145°F is the FDA's recommended minimum internal temperature for cooking steaks and roasts, 82% of respondents cook their beef products above this temperature to a level of doneness of medium or above.

Intervention Studies

A pilot plant study was conducted by ABC Research Corporation to determine the effectiveness of two intervention treatments to reduce the level of surface contamination on beef top sirloin butt subprimals prior to mechanical tenderization (7). An area on the top surface of individual subprimals was inoculated with a cocktail of four strains of *E. coli* O157:H7. This resulted in an initial count of 10^6 per cm^2. The inoculated subprimals were then spray treated with (a) acidified sodium chlorate (ASC) or (b) peroxyacetic acid (PAA) prior to tenderization. The subprimals were mechanically tenderized within one minute after the spray treatment. Five untreated controls were included in this study.

Uninoculated subprimals were also given the two intervention treatment before tenderization. These samples were used to determine the aerobic plate count and total *Enterobacteriaceae* on the surface and in a core sample. A 100 cm^2 surface sample, approximately 0.5 cm thick, was excised from the surface of the inoculated product and tested for *E. coli* O157:H7. A core sample of approximately 75 grams was also aseptically removed for *E. coli* O157:H7 analysis. The uninoculated tenderized subprimal were also sampled in the same way for testing for aerobic plate count and *Enterobacteriaceae*.

The PAA and ASC intervention treatments applied to the surface of the beef top sirloin butt subprimals were modestly, but significantly, effective in reducing the level of *E. coli* O157:H7. The PAA caused a 0.63 to 0.71 log reduction in the numbers of *E. coli* O157:H7 in the two pilot plant trials. The ASC treatment caused a significant 0.63 log reduction in one of two pilot plant trials. There was no significant reduction in the second trial.

Neither the PAA or ASC treatment caused a significant reduction in the aerobic plate count or in the level of *Enterobacteriaciae* on the surface.

The examination of the core samples showed that there was no significant reduction in *E. coli* O157:H7, aerobic plate count or *Enteriobacteriociae* in the samples treated with PAA and ASC.

Kansas State University conducted a study to evaluate the combined effect of a hot (80°F) lactic acid dip, vacuum packaging and subsequent microwave treatment on *E. coli* O157:H7 on the surface of 5.0 pound blocks of beef (2). A hot lactic acid dip lasting 2 or 4 seconds and a 60 or 70 second

microwave treatment resulted in a 1.0 to 1.5 reduction of *E. coli* O157:H7 and list what was analyzed. The acid and microwave treatments resulted in minimal color changes in the lean portion.

CONCLUSIONS

The incidence of E. coli O157:H7 on the surface of subprimals is rare. Only two of 1,614 subprimals examined in two surveys were positive for this pathogen and the quantitative count in both samples was < 3.0 CFU per 200 cm^2. During mechanical tenderization, the translocation of *E. coli* O157:H7 from the surface of subprimals into the subsurface muscle tissue does occur at a low level. However, cooking studies showed that non-intact beefsteaks and roasts provide no significant food safety hazard when they are heated to an endpoint temperature of at least 140°F. The NCBA funded studies also showed that when steaks and roasts are cooked properly, *Salmonella* and *L. monocytogenes* do not present a public health risk.

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