Project Summary

*Escherichia coli* O157:H7 and *Salmonella Typhimurium* Risk Assessment during the Production of Marinated Beef Inside Skirts and Tri-tip Roasts

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**Background**
Following the foodborne outbreak in late 1992 and early 1993 caused by *E. coli* O157:H7 associated with ground beef, the safety of beef products has been highly scrutinized. In 1994, USDA’s Food Safety and Inspection Service (FSIS) declared *E. coli* O157:H7 an adulterant in raw ground beef. In 1999, FSIS clarified that the public health risk of raw beef products contaminated with *E. coli* O157:H7 was not limited to ground beef, but also included non-intact beef products. These non-intact beef products include beef that has been injected, mechanically tenderized, or reconstructed.

Since the outbreaks of 1993, beef producers and packers have spent more than $420 million dollars on beef safety research. These investments have resulted in the publication of a significant amount of research data, best practices, and information to assist the industry in assessing and minimizing the overall risk of their processes and products. Due to FSIS’s expansion of adulteration to include non-intact beef products, a great deal of research surrounding food safety questions have been related to the risk associated with the production of non-intact beef.

A research study conducted at Kansas State University demonstrated that blade tenderization could transfer pathogens from the surface of beef steaks to the interior tissue. However, several gaps and questions still remain related to the production of non-intact products, specifically related to marinating or enhanced products. For example, does the same translocation of bacteria from outside to inside occur during marination of beef roasts that occurs during tenderization of beef steaks, and if so, how far do the pathogens penetrate?

The importance of food safety and the emphasis of production practices to reduce pathogens are crucial to the success of the industry. To provide additional information that establishments can use to strengthen their food safety programs, this project evaluated the effect of inoculated marinade used in vacuum tumbling on pathogen penetration into two different commonly marinated beef cuts. The marinade was inoculated with *S. Typhimurium* and *E. coli* O157:H7 before the product was enhanced by vacuum tumbling. The overall result showed that during the process of vacuum tumbling with inoculated marinade, the microorganisms penetrated the same distance as the marinade into the beef product. Also, the microorganisms survived in spent marinade and in beef product while being stored under refrigerated conditions.

The objective is to investigate the survival of *Escherichia coli* O157:H7 and *Salmonella* spp. in beef marinades and the transfer of these organisms from the marinades into muscle tissue through the process of vacuum tumbling.

**Methodology**

This study was conducted to determine the survival of *Escherichia coli* O157:H7 and *Salmonella* Typhimurium in marinade that was used to vacuum tumble beef inside skirts and beef tri-tip roasts. The depth of penetration of each microorganism into the individual meat products, and the survival of these microorganisms in the products, as well as marinade stored over time were evaluated. Two commercial marinades were used, Reo TAMU Fajita Marinade and Legg’s Cajun Style Marinade. Eighteen beef inside skirts and 18 tri-tips were used during this study. Both inside skirts and tri-tips
were vacuum tumbled for a total of 1 h. Both products were sampled immediately following tumb
ing (day 0), or were vacuum packaged and stored in the cooler (approximately 2°C) for subse
quent sampling on days 7 and 14 days. Samples of the spent marinade were taken and tested ini
tially following tumbling (day 0), and were also stored in a cooler and tested 3 and 7 days after the marinade was used.

Findings
The results of the study showed that with both of the marinades \textit{S}. Typhimurium and \textit{E. coli} O157:H7 penetrated throughout the entire inside skirt. After having been stored for 7 days following tumbling, the log value of both \textit{S}. Typhimurium and \textit{E. coli} O157:H7 decreased for the inside skirts. After 14 days of storage following tumbling, the log value of both \textit{S}. Typhimurium and \textit{E. coli} O157:H7 continued to decrease; however, both pathogens were still detectable.

The penetration of the pathogens in the tri-tip roast varied depending on the thickness of the roast. The thicker roasts had undetectable levels of both pathogens in the geometric center; however, the thinner tri-tip roasts had detectable levels at the geometric center. The spent marinade tested on day 0, 3, and 7 showed that the microorganisms were able to survive in the marinade at refrigerated temperatures.

Overall, the results of this study demonstrated that pathogens may penetrate into the interior of beef skirts and tri-tips during vacuum tumbling with contaminated marinade, and that pathogens survive during refrigerated storage of spent marinade.

Implications
\textit{E. coli} O157:H7 and \textit{S}. Typhimurium are a major food safety concern to the beef industry. Although the \textit{E. coli} O157:H7 prevalence is typically low on beef subprimals, processors must still be concerned about contaminating marinade. If processors reuse spent marinade, they need to be aware of the potential risk of contaminating products during subsequent marination. The survival of pathogens in spent marinade, and the transfer of pathogens into the interior during vacuum tumbling may both contribute to potential food safety concerns. If spent marinade is re-circulated or used on subsequent production days, then processors may need to consider using some type of antimicrobial process or ingredient before using the marinade. In conclusion, this research provides useful information that processors of non-intact beef products should consider when developing food safety programs to address all potential food safety hazards, including \textit{E. coli} O157:H7 and \textit{Salmonella} Typhimurium.

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