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Escherichia coli O157:H7 risk assessment for blade-tenderized beef steaks

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ESCHERICHIA COLI O157:H7 RISK ASSESSMENT FOR BLADE-TENDERIZED BEEF STEAKS

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Summary

The potential translocation of *E. coli* O157:H7 from the surface to the interior of whole muscle by blade tenderization was evaluated. Beef top sirloin subprimals were inoculated with 10^6 or 10^3 cfu/cm^2 and passed once through a Ross blade tenderization unit. Core samples showed a translocation of 3 to 4% of surface inoculum to the geometric center of the subprimal. A second study evaluated thermal destruction of *E. coli* O157:H7 in blade tenderized (BT) steaks compared to nontenderized (NT) steaks of three thicknesses when oven-broiled. Subprimal surfaces were inoculated to a level of 10^7 cfu/cm^2 and blade tenderized. Steaks cut from these subprimals were oven-broiled to internal temperatures from 120 to 170°F, then analyzed for surviving *E. coli* O157:H7. At internal steak temperatures of 140°F and higher, all *E. coli* O157:H7 were killed in both BT and NT steaks of all thicknesses. At 130°F, about 5 log reductions were noted for both BT and NT. With oven broiling to even moderate internal temperatures, BT steaks pose no greater risk of *E. coli* O157:H7 infection than NT steaks.

(Key Words: Blade Tenderization, Beef Steaks, Risk Assessment, *E. coli* O157:H7.)

Introduction

Blade tenderization of subprimals offers a cost-effective way to achieve uniform and acceptable tenderness in beef cuts. However, microbiological quality and associated health risks have not been researched thoroughly. Ground beef generally is cooked medium to well-done, because restaurants and consumers now realize that *E. coli* O157:H7 and other pathogens may be present in the product. However, consumers generally perceive that intact muscle steaks, even when blade tenderized, require cooking to lesser doneness. Mechanically tenderized steaks could harbor pathogenic bacteria internally, thereby increasing risk of foodborne infection if not thoroughly cooked. Our objectives were to determine the extent to which blade tenderization translocates microbial contamination from the surface to the interior of subprimals and to determine cooking parameters required to eliminate *E. coli* O157:H7 from the interior of blade tenderized steaks.

Experimental Procedures

Penetration of *E. coli* O157:H7 during Blade Tenderization

A rifampicin-resistant strain of *E. coli* O157:H7 (USDA-FSIS 011-82) was grown and diluted to provide inocula levels of 10^3 and 10^6 cfu/ml. Vacuum-packaged top butt subprimals (caps removed) were removed from packaging, and the inoculum was misted onto their surfaces in an airtight chamber. The inoculated subprimals were stored at 39°F for 30 min to allow attachment. Then each subprimal was passed once through a blade tenderizer (Ross TC700M, Midland, VA), which produced 32 blade penetrations per sq in. The unit was disassembled, cleaned and sanitized after passage of each subprimal. Tenderized suprimals were stored in a freezer at 0°F for 3 hours to crust the surface and facilitate accurate removal of core samples.

Tenderized subprimals were transferred aseptically to clean butcher's paper with the inoculated side down. Four cores were excised from each subprimal using sterile coring devices (4 in. long, 2 in. diameter),

beginning from the noninoculated surface. Meat cores were removed carefully through the back opening of the coring device to prevent artificial contamination of the core surface. Approximately 2 mm of the noninoculated surface of each core was trimmed aseptically, and the cores were sliced aseptically into four cross-sections of 2, 2, 1, and 1 cm. Cross-sectional strips were homogenized in 0.1% peptone diluent (1:5;w:v) in a sterile blender jar. Serial dilutions were plated onto TSA-rif agar to enumerate *E. coli* O157:H7 at each core depth.

Determining Adequate Cooking Temperatures for BT Steaks

Five strains of *E. coli* O157:H7 were grown, and a mixed-strain inoculum was prepared in 0.1% peptone water. Six top butt subprimals were mist-inoculated in a sealed chamber to provide 10^7 cfu/cm^2 on the top exterior surface. After a 1-hour attachment period at 39°F, three subprimals were blade tenderized (BT), and the other three served as inoculated but nontenderized (NT) controls. Steaks were cut from each subprimal at thicknesses of 0.5, 0.75, and 1.25 in, and the noninoculated edge of each steak was trimmed to provide weights of 5, 8, and 12 oz, respectively. Steaks of each thickness were assigned randomly to one of six target internal temperatures (120, 130, 140, 150, 160, or 170°F) and cooked under a typical kitchen oven broiling element set at 500°F, which provided an ambient temperature of about 300°F. Steaks were turned after reaching the mid-point temperature. Internal temperatures were monitored at 10-sec intervals using a thermocouple threaded through the steak edge to the geometric center. After reaching the target internal temperature, steaks were sealed in sterile stomacher bags, and placed into an ice bath.

After chilling, a cross-section strip was excised aseptically from the center of each steak, parallel to the blade penetrations and representing both the inoculated surface and the steak interior. These samples were placed into sterile blender jars with 0.1% peptone water (1:5 w:v) and homogenized for 30 sec. Surviving *E. coli* O157:H7 were enumerated on MacConkey Sorbitol Agar (MSA) and Phenol Red Sorbitol Agar (PRSA; to enumerate injured cells). Log reductions were calculated based on analysis of uncooked steaks from each treatment group. Samples testing negative by plating were selectively enriched and qualitatively analyzed by plating enrichments onto MSA agar. Presumptive *E. coli* O157:H7 colonies were confirmed biochemically and serologically. Three replications were completed.

Results and Discussion

Penetration of *E. coli* O157:H7 during Blade Tenderization

Blade tenderization translocated surface *E. coli* O157:H7 throughout the muscle interior. The high-level surface inoculum (10^6 cfu/cm^2) resulted in about 3 logs of *E. coli* O157:H7 being translocated to a depth of 6 cm into the subprimal. The geometric center of each core sample harbored 4 log cfu/g. The low-level inoculum (10^3 cfu/cm^2) produced similar trends; approximately 1.8 logs were transferred to the center of the steaks. Blade tenderization carried 3 to 4% of surface contamination to the center of the subprimals, regardless of initial surface contamination level.

Determining Adequate Cooking Temperatures for BT Steaks

Steaks were oven broiled to internal temperatures from undercooked (120°F) to well-done (170°F). No difference ($P>0.05$) was noted between BT and NT steaks in *E. coli* O157:H7 survival, except at 120°F internal temperature, where BT steaks showed less bacterial reduction than NT steaks (3.2 and 5.2 log cfu/g respectively). At an internal temperature of 130°F, mean log reductions of 5.6 and 5.0 cfu/g for BT and NT steaks, respectively, were not different ($P>0.05$). However, evaluation of individual steaks indicated significant variability in degree of kill, particularly in thinner (lower weight) steaks. This variability in cooking to 130°F could increase the risks associated with BT steaks potentially contaminated internally with *E. coli* O157:H7. At temperatures of 140°F and higher, all *E. coli* O157:H7 were eliminated by oven broiling.