Project Summary

Influence of Case-Ready Packaging on Premature Browning of Ground Beef and Top Sirloin Butts

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Background

Highly publicized outbreaks of food-borne illness since 1993, primarily caused by bacteria such as *E. coli* O157:H7, *Salmonella spp*. and *Listeria monocytogenes*, elicited intense consumer concern about meat safety. In response, regulatory authorities, researchers and the beef industry initiated efforts to implement food safety management systems that would improve microbiological quality. The USDA Food Safety and Inspection Service (FSIS) began initiating new regulatory requirements during the mid-1990s. Packers were required to knife-trim carcasses to remove all visible contaminants, comply with written sanitation standard operating procedures (SSOP), implement Hazard Analysis Critical Control Point (HACCP) systems, and meet microbiological performance criteria and standards for *E. coli* and *Salmonella* as a means to verify HACCP effectiveness and pathogen reduction.

If *E. coli* 0157:H7 is present in ground beef (and this is a rare occurrence) cooking to an internal temperature of 160$_{o}$F will render the bacterium harmless. Premature browning of ground beef could lead to inadequate cooking by consumers and allow the survival of *E. coli* 0157:H7 if it is present. The objectives of this study were to determine the effect that the following factors have on premature browning of ground beef patties and sirloin steaks:

- The effect of meat source
  - ground top loin,
  - ground chuck,
  - ground table trim, or
  - top sirloin butt steak;
- the effect of packaging system
  - vacuum-control,
  - 80% oxygen modified atmosphere packaging (MAP), or
  - 0.4% carbon monoxide MAP; and
- the effect of storage time (7, 14 or 21 days).

Methodology

Boxed beef (top loins, shoulder clods, 85/15 table trim, and top sirloin butts) were obtained the day of packaging from a commercial packing facility. All but the top sirloin butts were ground and packaged in 1 lb. portions under anaerobic conditions (ABC), in (1) modified atmosphere containing 80% O_2 and 20% CO_2 (MAP-O_2) or (2) in modified atmosphere containing 0.4% CO, 30% CO_2, 69.6% nitrogen. The packages were stored at 2° C, and two packages from each meat source and packaging system were removed for study after 7, 14, or 21 days. Three 1/4 lb portions of the meat from each package (6 in total) were manually formed into patties. Any ground meat not made into a patties (about 4 ounces per package) was combined according to meat type and packaging system, vacuum packaged, and stored frozen at -20°C for later analysis. One patty from each treatment was used for chemical analysis, pigment analysis, and instrumental color analysis. The remaining patties from each package were cooked on a grill, one patty to each of five end point temperatures (120°F, 135°F, 150°F, 160°F, and 175°F). The cooked patties were used for chemical analysis, pigment analysis, and color analysis.

The top sirloin butts were handled somewhat differently because it was not possible to obtain enough steaks from a single butt to complete all treatments. Each of three top sirloin butts were knife-cut lengthwise into three sections, and each section was assigned to a treatment (packaging x storage time). Packaging followed the same procedure as the ground meats. Seven 3/4" thick steaks were cut from each section, packaged, and stored at 4°C. One steak from each sirloin butt section was stored frozen for later chemical analysis to establish baseline values. One steak from each sirloin butt section was used for chemical analysis, pigment analysis, and instrumental color analysis. The others were cooked on a grill, one steak to each of five end point temperatures (120°F, 135°F, 150°F, 160°F, and 175°F). The cooked steaks also were used for chemical analysis, pigment analysis, and color analysis.

Findings

Overall, premature browning was evident for all end point temperatures in ground beef and top sirloin steaks that were packaged in 80% oxygen modified atmosphere, whereas beef samples vacuum-packaged or packaged with 0.4% carbon monoxide MAP did not exhibit premature browning.

- Ground beef packaged in 80% MAP appeared done at cooking temperatures as low as 135°F (USDA recommends an internal temperature of 160°F in order to eliminate any pathogens that might be present).
- In addition, elevated levels of thiobarbituric acid reactive substances (TBARS) were found in the beef stored in 80% oxygen MAP, suggesting the development of rancid flavors.
- The problems of rancidity and premature browning were generally avoided by packaging fresh beef in 0.4% carbon monoxide, 30% $CO_2$and 69.6% nitrogen MAP (This low level of CO developed a stable red color with no perceived consumer health issues related to inhalation of CO).
- Problems with rancidity and premature browning were also generally avoided by vacuum-packaging beef. One drawback to this packaging method is that the beef does not exhibit the bright red color that consumers associate with freshness.

Implications

The Centers for Disease Control (CDC) estimates that there are 76 million cases of foodborne illness in the United States annually, with 14 million cases attributed to known pathogens. *E. coli* alone is estimated to account for 76,000 cases of food-borne illness and 76 deaths annually. Multiple intervention strategies to inhibit or eliminate *E. coli* in the beef production process are extremely important to the industry. Further, safe handling and proper cooking by consumers is the final defense against food-borne illness. The results of this study revealed two drawbacks to the packaging of fresh beef in high oxygen MAP. After cooking, ground beef or sirloin steaks stored 7 days in 80% oxygen- MAP developed rancid flavor, and browned easily during cooking (the premature browning effect; PMB). PMB is of concern, since beef exhibiting PMB appears done at cooking temperatures below the recommended level to achieve pathogenic inactivation (i.e. 160_oF).