

Project Summary

Packaging and Product Effects on Sensory, Shelf-Life and Color of Beef

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Background

The cutting and packaging of beef at retail has undergone many changes, from whole carcasses fabricated in retail backrooms, to tray-ready and now to case-ready beef. Currently, the majority of beef sold at retail is centrally packaged into primal and subprimal cuts, vacuum packaged and shipped as “boxed beef.” Retailers can purchase based on local preferences and buy the mix of beef cuts that fit specific consumer buying habits by store. Case-ready beef takes this one step further by packaging specific grinds of hamburger, steak and roast cuts at a central location ready for sale at the retail level. There are many options available for case-ready packaging systems; from over-wrapped trays that mimic in-store packaging to modified atmosphere sealed trays that contain differing levels of oxygen and/or nitrogen.

Modified atmosphere packaging (MAP) has been around for a long time. Recent innovations in packaging films and equipment technology have expanded packaging options for whole muscles. Each system has its own advantages and disadvantages which necessitates careful consideration of all features when a packaging option is selected for a given beef product.

High-oxygen packaging systems help impart the bright red color of fresh beef. However, these systems also accelerate the extent to which the red color is converted to brown. Thus, an assessment of the capability of a high-oxygen packaging system to build and sustain color is in order. Low oxygen systems do not impart a bright red color, but they should sustain the color in the retail case. One exception is if residual oxygen remains within the package. In this circumstance, the color could turn to brown very quickly. There is a need to determine the extent to which this detrimental change to color occurs.

Recently, there has been a strong interest in the marketplace for enhanced beef products. In most cases, beef is pumped with a variety of compounds designed to enhance its texture, flavor, and consistency. The ingredients typically include salt, phosphate, sodium lactate, and seasoning and flavorings that both protect flavor stability (reduce oxidation) and enhance flavor perception. Performance of enhanced products in modified atmosphere packages should be evaluated.

Methodology

USDA select grade beef strip loins (n=19) and top sirloin butts (n=37) were selected at a commercial meat processing facility. At the plant, each primal was weighed, pumped with a commercial enhancement solution, and sliced into 1-inch thick steaks using a commercial slicer. They were then packaged using one of three packaging systems: 1) using a Ross 3320, approximately one third of the steaks were placed in a high-oxygen barrier tray with a gas mixture approximately 20% carbon dioxide and 78% oxygen, 2) placed in a peelable tray using a Ross Junior model S3180 with an atmosphere containing about 22% carbon dioxide, 78% nitrogen and just 223 ppm of oxygen, or 3) vacuum packaged in a Cryovac machine into barrier bags. Top sirloin steaks were lightly misted with a solution containing Rosemary extract to minimize oxidation.

Steaks were allocated into one of two periods of dark storage (8 or 15 days), to be followed by one or three days of retail display. During the display, a team of experienced evaluators rated the steaks for color and extent of surface discoloration. Color was rated on a five-point scale where 1=extremely bright red and 5=dark red or brown (for non-vacuum packaged steaks) or where 1=bright purplish red and 5=brown for the vacuum packaged steaks. At the end of the retail display period, an objective measure of color was obtained using a hand-held Hunter colorimeter. Readings were taken immediately after removing the steaks from the packages and again after a one-hour bloom period. The steaks were then frozen for later evaluation by a trained, 10-member sensory panel.

The panel evaluated juiciness, tenderness, intensity of flavor/off-flavor and desirability of flavor. All sensory traits were evaluated on 8-point rating scales, where 1=extremely dry, extremely tough, extremely bland flavor, no detectable off-flavor, and extremely undesirable flavor and 8=extremely juicy, extremely tender, extremely intense flavor, extremely intense off-flavor, and extremely desirable flavor. Steaks were cooked to 70 C (160°F) on Farberware Open Hearth broilers and then sampled and rated by the panelists.

Findings

Color and Color Stability

Generally, all of the packaging options had acceptable color and discoloration scores at the start and after one day of the retail display. After one day, discoloration dramatically increased for all of the packaging systems stored for 15 days prior to display, with the exception of the vacuum packaged sample. The least desirable discoloration scores were noted for the low oxygen (peelable) packaging system after 8 and 15 days of storage and the high oxygen (barrier) tray system after 15 days of storage. Nearly identical patterns for color and discoloration ratings were observed between the strip steaks and the top sirloin steaks, except that the top sirloin steaks had greater discoloration and less desirable color.

Storage time and retail display time each contributed nearly equally to discoloration. In broad terms, the detrimental effects of dark storage and retail display time appear to be additive. That is, the least desirable colors within a packaging system were obtained for steaks stored for 15 days and displayed for three.

Sensory Traits

Across all sensory traits except tenderness, the general pattern was for sensory traits to decline in desirability during dark storage and retail display. Collectively, three packaging/storage combinations were commonly rated the lowest - the low oxygen (peelable) tray system and the high oxygen (barrier) system (especially after 15 days of storage and 3 days of retail display).

Juiciness scores decreased with extended storage and were lowest for the two systems mentioned above (low oxygen peelable tray and high oxygen barrier system). The same trend was apparent for top sirloin steaks as for strip steaks. One exception was the tendency for the low oxygen (vacuum) system to be less juicy after 15 days of storage and 3 days of retail display.

No meaningful trends in tenderness were detected by the panel.

Flavor intensity tended to increase with storage and retail display times, and off-flavor intensity ratings followed the same pattern. Apparently, the off-flavors detected by the taste panel provided the more intense flavor. Extended storage and long retail display created conditions leading to the poorest ratings.

Flavor preference ratings were consistent with the other sensory traits; as storage time increased flavor preference ratings decreased. The consequence of extended dark storage (15 days versus 8) was especially detrimental to flavor preference, sometimes resulting in a decline by one full unit on the rating scale. These are substantial declines and should be avoided if at all possible.

Implications

Color of fresh beef during retail display is an important factor used by consumers to judge freshness and make their purchase decision. A bright, cherry-red muscle tissue color is desired. Recession of the cherry-red color during product display, and the appearance of brown hues, is a natural process in beef, and occur prior to microbial spoilage. Beef products that are in the early stages of discoloration may be discounted to encourage quick sale to more price-conscious consumers, seasoned or marinated into products for which fresh meat color is not pertinent, or converted to ground beef. Products with advanced discoloration are likely to be discarded. Each of these options contributes to losses in value and sales of beef at retail. U.S. retailers fail to capture at least one billion dollars of revenue annually from fresh beef sales, due to product discoloration.

The findings of this study suggest that there are several general recommendations that can be made. First, minimize the extent of dark storage and retail display. The flavor consequences of reaching the end of the display life are profound. Second, the low oxygen (peelable) tray system did not perform well at all in this test. Perhaps the machine was not in proper working order (although it appeared to us and to experienced plant personnel to be operating correctly). Further study is needed to evaluate this system again, along with the other packaging system that was not studied here (high oxygen with a master pack concept).

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