Project Title: Antioxidant-Impregnated Packaging Films to Extend the Shelf-Life 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.

High-oxygen packaging systems help impart a bright red color of fresh beef. Research has shown that the most important considerations for consumers in choosing fresh beef are the color of the meat and the expiration data. The main objective of this study was to measure the effects of adding two antioxidants to the plastic film that is in contact with fresh beef when wrapped for retail display.

Methodology

The research was divided into two separate experiments. The first experiment determined the rate of migration of the antioxidants from the films while the second experiment tested the effect of antioxidant films on meat color stability.

Experiment 1: Film disks 23mm in diameter were formed using low density polyethylene (LDPE) and polyvinyl chloride (PVC). The films were loaded with 0, 0.5 or 1.0 % of either BHA or BHT, then placed in 95% ethanol (the FDA fat simulant) and the ethanol was sampled for concentration of antioxidant at 1, 2, 4, 6, and 8 days. Ethanol was used since in previous experiments water was used and showed significantly lower migration rates than ethanol.

Experiment 2: Utilized BHT, BHA, δ-tocopherol and Herbolox (commercial rosemary preparation) each at 0.5 and 1.0% levels added to low density polyethylene films. Antioxidant film disks were applied to a freshly cut 0.5 inch thick eye of round steak that had been allowed to bloom in air for 30 minutes. Four film disks were placed on the surface of each steak with each disk being a different treatment. Treatments included a control film disk with no antioxidant added and films with both 0.5 and 1.0% addition of BHT, Herbalox, and δ-tocopherol. The steaks with the film disks on the surface were over-wrapped and vacuum-sealed. Colorimeter readings were taken each day, including immediately after packaging, using a Minolta Colorimeter Model 300.

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Findings

Experiment 1
Experiment 1 tested the migration rates of BHT and BHA from the film materials into FDA food simulants. Determination of the quantity of antioxidant migrating from the film in model simulants will be needed for FDA and USDA approval should this technology be applied to commercially. Any concern about the amount of synthetic antioxidant in the meat can be addressed through such studies. Also, migration rates can be helpful in optimizing antioxidant capability while minimizing costs. Migration into ethanol (FDA fat simulant) showed that at 1% loading, BHA and BHT were less than 300 ppm after 8 days of exposure. BHA was found to migrate at approximately twice the rate of BHT from both polyvinyl chloride (PVC) and low-density polyethylene (LDPE). The film material type (LDPE or PVC) had little effect on the rate of diffusion of BHA, however, BHT migrated at over twice the amounts from LDPE compared to PVC when loaded at the same amount. BHT did not migrate into water in measurable amounts while BHA migrated at lesser rates from LDPE and PVC into water than was found with ethanol (fat simulant). In either fat or aqueous FDA simulant, antioxidants migrated to a greater degree from LDPE than from PVC.

Experiment 2
Experiment two determined the effect of antioxidant films on steak color stability. Steaks tended to become lighter over time with no significant difference due to film treatment. Redness was higher overall for steaks in contact with 1.0% BHA- or BHT-impregnated film disks. Redness remained higher through 3 days for steaks packaged with films containing 0.5% or 1.0% BHA and 1.0% BHT compared to steaks packaged in films without any antioxidant added. The results indicate that antioxidant packaging can slow oxidation in fresh beef and the development of a brown appearance. Furthermore, the type of antioxidant and type of film material will be important future considerations as this study found both factors have significant effects on the rate of antioxidant migration and subsequently the effectiveness of the packaging on maintaining meat color.

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 antioxidant-impregnated film material can extend the red color of fresh beef, possibly by 1-2 days. Further studies are warranted that examine higher levels of antioxidants, especially δ-tocopherol, and if there is a synergistic effect when multiple antioxidants are used.

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