BEEF COLOR WITH INCREASED POSTMORTEM FABRICATION AND AIR EXPOSURE TIMES

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SUMMARY

Coarse ground beef from chuck and loin primals were fabricated at ½, 48 and 96 hr postmortem, stored in vacuum packaging, and ground beef patties and steaks were exposed to air for 0, 5, 10, 20, 60 or 120 min (ground) or 0, 15, 30, or 45 min (steaks) before air-permeable overwrap packaging and simulated retail display at 4°C. HunterLab L and b values decreased with increased postmortem time and increased with air exposure of 0 and 10 min for ground beef and 30 and 45 min for steaks. The a values increased with air exposure of 20 and 60 min for ground beef patties. Depth of oxygenation increased in steaks compared with ground beef, with increased air exposure, and with increased display time.

INTRODUCTION

Color is an important trait influencing red meat purchases by consumers (Lynch et al., 1986). Display of beef in oxymyoglobin (bloomed) pigment state is necessary because consumers uneducated about meat color are unfamiliar with deoxymyoglobin (purple) pigments (Lynch et al., 1986) and discriminate against meat with more than 20% metmyoglobin pigment (MacDougall, 1982).

Beef oxymyoglobin is obtained with greater than 40 torr partial pressure of oxygen (Rizvi, 1981) common in air-permeable films, such as polyvinyl chloride (PVC). At 3.3°C, color fading and pigment oxidation often occurs with meat wrapped in PVC within 5 days (Pierson et al., 1970). Shorter storage times in primal vacuum packaging (VP) (Seideman et al., 1979) reduce meat discoloration during display. Madhavi and Carpenter (1993) reported that color was most stable in steaks fabricated at 4 or 7 days postmortem as compared with 2, 14 or 21 days postmortem.

Preliminary observations indicated that amount of time between fabrication or grinding and air-permeable overwrap packaging would alter color development. Color reflectance and depth of oxygenation in ground beef and loin steaks with differing postmortem, fabrication-packaging, and display times were measured.

MATERIALS AND METHODS

Crossbred Brahman beef steers were slaughtered at the Louisiana State University Agricultural Center Meat Laboratory after 200 days on feed (68.5% TDN, 10.5% CP). Chuck (infraspinatus and supraspinatus) muscles were removed at ½, 48 or 96 hr postmortem, ground (1.25 cm plate), vacuum packaged, and stored in the dark at 2°C. At 10 days postmortem, the coarse ground beef was ground (4.8 mm) and hand-formed into patties of 10 mm thickness in a square mold plate (10.5 x 10.5 cm). Patties were cut in half, weighed and placed onto foamed polystyrene trays. After 0, 5, 10, 20, 60 or 120 min exposure to ambient air, patties and trays were overwrapped with polyvinyl chloride film (PVC) (Borden Resinite, O_2 transmission of 325 cc/cm^2/24 hr and CO_2 transmission of 2500 cc/cm^2/24 hr) and displayed under 500 lux cool white fluorescent lighting at 5°C for 4 or 8 hr. At ½, 48 or 96 hr postmortem, boneless loin (M. longissimus lumborum) primals were cut from carcasses, vacuum packaged and stored in dark at 3°C. On day 26 postmortem, loin steaks were chilled for 1 hr at -29°C, sliced to 1.9 cm thickness, and exposed to air for 0, 15, 30 or 45 min before overwrapping with PVC. Steaks were displayed under 500 lux cool white fluorescent lighting at 4°C for 0, 6, 12, and 24 hr.

Objective color analyses of L (lightness), a (degree of red/green), and b (degree of yellow/blue) values (LABSCAN-2 0/45, Hunter Associate Laboratory, Inc., Reston, VA) were averaged on each patty or cut by

rotating samples 90° between each of 3 readings. Depth of oxygenation from the surface to the interior was measured with digital calipers. Each steak or patty and tray liner were weighed separately at initial packaging and at sampling. The statistical model was a split-plot design with animals as replications, plots of postmortem fabrication time and prepackaging air exposure time, and sub-plot of display time. Data were analyzed by analysis of variance (ANOVA) with general linear model (GLM) procedures (SAS, 1985). When significant differences ($P<0.05$) were detected, treatment means were separated by the Least-Square Means procedures.

RESULTS AND DISCUSSION

Increased time of postmortem fabrication decreased ($P<0.05$) HunterLab L values and increased HunterLab a values for ground beef and decreased a values for steaks (Table 1). L and b values of steaks were lowest with fabrication at 48 hr postmortem. Air exposure for 0 and 10 min before overwrap packaging of ground beef patties increased L and b values while exposure for 20 and 60 min increased a values. Display of ground beef for 8 hr increased L values and decreased a values compared with 4 hr display. L and b values increased ($P<0.05$) and a values decreased ($P<0.05$) when loin steaks were exposed to air for 30 and 45 min. Color value differences were minimized after display for 6, 12 (data not shown), and 24 hr. ANOVA indicated an interaction ($P<0.05$) between air exposure time and display time for loin steaks, but no interactions among main treatments for ground beef. Fellers et al. (1963) reported that loin samples reached peak bloom (a value) at 22 min air exposure time. Proportion of oxymyoglobin pigment increased with increased exposure to air and decreased with increased storage time (Pierson et al., 1970).

Weight retention did not vary greatly, but decreased with postmortem and air exposure times. Depth of oxygenation was less in ground beef than steaks (Figure 1). Oxygenation depth with 96 hr postmortem ground beef and 48 and 96 hr postmortem steaks was greater than with ½ hr postmortem time. Oxygenation depth increased ($P<0.05$) with time of display for both ground beef and steaks (Figure 1). Depth of oxygenation was decreased with short (5 to 15 min) air exposure times compared with longer air exposure times. O'Keeffe and Hood (1982) reported that depth of oxygen penetration increased with exposure time in air and with sampling time postmortem. Bendall and Taylor (1972) reported that oxygen consumption rate decreased with time postmortem, but increased with added ATP. Fabrication time and fabrication method and display time influence discoloration and oxygen consumption rates (Madhavi and Carpenter, 1993). Regeneration of energy sources and degree of oxygen consumption and oxygen binding appear to be influenced by time postmortem, resulting in differing oxygen penetration with air exposure compared with relative color development.

CONCLUSION

Time of fabrication or grinding postmortem, exposure to air before permeable overwrap packaging and display influenced development and retention of color as measured by objective reflectance values. Depth of oxygenation was altered by the differing times, but did not appear related to bloomed color development or maintenance. Additional studies are warranted to determine the relationships among biochemical mechanisms, oxymyoglobin formation and visual color values.

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