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Color formation and retention in fresh beef (1987)

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Color Formation and Retention in Fresh Beef

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Summary

We conducted two studies in response to a severe problem with ground beef color encountered by beef fabricators and retailers. We concluded that: (1) Loss of muscle chemical-reducing capability upon grinding, with subsequent color deterioration, results from both the mechanical effect of grinding and incorporation of oxygen into the beef. (2) Flat, thin, surface muscles from beef carcasses retain more ability to bloom (turn bright red) if they are removed by hot boning or after a relatively short chill period.

Introduction

To the purchaser, meat color is an important quality consideration. Our distribution, packaging, and marketing system for fresh meat is organized to present bright red meat to the purchaser. The preferred bright red color, especially for beef cuts and ground beef, is a result of oxymyoglobin, and purchasers consider lack of this color to be a sign of product deterioration. Such discolored meat is usually sold at a substantial discount.

Oxidation is a common but undesirable kind of color deterioration in beef cuts, trim, and ground product. Fresh beef muscle has a chemical-reducing capacity that slows oxidation, but is gradually lost. The loss is more rapid when muscle is exposed to oxygen. Current processing-packaging-marketing systems expose beef and beef trim to oxygen for various times prior to coarse grinding and vacuum packaging. A high level of oxygen exposure and diffusion of oxygen into the muscle is detrimental, when they occur before vacuum packaging. Holding trim for long times or using a high proportion of the carcass surface muscles that have had maximal surface exposure to air are likely to cause degraded color in the finished product.

Much of the ground beef currently marketed is coarsely ground and vacuum packaged in oxygen-impermeable (keeper) casing, then finely ground at the supermarket. Such beef may fail to "bloom" or turn bright red, causing a serious problem for the industry.

We conducted two studies to help understand this problem.

Experimental Procedures

Study 1. Three beef carcasses, grading U.S.D.A. High Good or Choice and weighing 650 to 750 lbs were used. Semimembranosus muscle was removed from each chilled side. Meat from one side was vacuum packaged immediately to

minimize oxygen diffusion into the muscle. It was placed in an isolation hood for cutting and ground twice through a 1/8 inch plate. A nitrogen atmosphere was maintained, with oxygen at 0.1% or less. Semimembranosus muscle from the other side was cut and ground in air with other conditions being similar.

Ground beef from both sides was placed in oxygen impermeable bags, vacuum packaged, and stored for either 7 or 14 days prior to a display study. After storage, product was unpackaged, finely ground, and re-packaged in polyvinyl chloride.

The polyvinyl choride-wrapped product was displayed under 90 foot candles G.E. Natural fluorescent lighting for 24 hours per day at 4 C. Color was evaluated at the beginning of display (0 time) and after 1, 3, and 5 days of display by four panelists. Scoring was to the nearest 0.5 point on the K.S.U. beef color scale (1=very bright red, 3=slightly dark red or brown, 5=extremely dark red or brown). Reflectance data were taken with a Hunterlab D-54 reflectance spectrophotometer at the same times and percent metmyoglobin was calculated.

Study 2. Three beef carcasses grading Good or Choice and weighing 600 to 700 lbs. were used. Cutaneous trunci and adductor muscles were hot-boned from one side of each carcass within 2 hours postmortem, ground, vacuum packaged, and stored for either 7 or 14 days. After storage, the muscle was ground through a 1/8 inch plate and repackaged in polyvinyl chloride film.

The same muscles from the other chilled carcass sides were removed 48 hours postslaughter and handled in the same manner as the hot-boned muscle. Display conditions were similar to those of Study 1.

Results and Discussion

Study 1. Samples cut and ground in a nitrogen atmosphere had slightly less brown metmyoglobin ($P<.05$) and a slightly brighter red ($P<.05$) visual color (Table 15.1). We conclude that the loss of muscle-reducing capabilities results from both the incorporaton of oxygen into the meat and the physical effects of grinding.

Study 2. The cutaneous trunci is a flat, thin, surface muscle into which oxygen can diffuse easily while the carcass is intact. The muscles that were removed within 2 hours (hot) and ground prior to being placed in a 1% oxygen atmosphere had less metmyoglobin at all evaluation times after repackaging. This suggests a higher level of chemical-reducing activity in the hot-boned muscles, since their exposure to oxygen is minimized.

Very little visual difference was noted between hot and cold boning for cutaneous trunci before display and after 1 day of display (Table 15.2). However, after display for 3 to 5 days, color tended to be brighter for the muscle removed hot. The adductor, a muscle located deep in the beef round, was not affected by hot versus chilled boning.

These results suggest that removing surface muscles from the carcass before or early in chilling can minimize exposure to oxygen.

Table 15.1. Effect of Cutting and Grinding Muscle in Air Versus Nitrogen on Display Color and Metmyoglobin Reducing Capacity

Trait	Air	Nitrogen
Metmyoglobin, %[a]	24.2^{y}	20.2^{x}
Visual Color Score[ab]	2.76^{y}	2.59^{x}

[a] Average of all display times.

[b] 2 = bright red, 3 = slightly dark red or brown.

[xy] Means in the same row with different superscript letter are different ($P<.05$).

Table 15.2. Effect of Hot Versus Cold Removal of Beef Cutaneous Trunci Muscle on Visual Color[a] during Display

Time, days	Visual color[a]	
	Hot	Cold
0	1.62^{x}	1.49^{x}
1	1.88^{x}	2.00^{x}
3	2.58^{x}	3.03^{x}
5	3.34^{x}	3.80^{y}

[a] Visual color: 1 = very bright red, 3 = slightly dark red or brown, 5 = extremely dark red or brown.

[xy] Means in same row with different superscripts are different ($P<.05$).