IMAGE ANALYSIS TO QUANTIFY COLOR DETERIORATION ON FRESH RETAIL BEEF

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Keywords: Image analysis, vitamin E, beef, retail, color

Background

Two problems, cited by USA supermarket meat managers, which cause beef retail meat packages to be discounted or discarded are poor workmanship and discoloration. Poor workmanship which displays too much fat or bone and therefore lowers the perceived value of the retail beef cut can be remedied through better procurement specifications, management and training. However, discoloration of fresh beef can be a much more complex problem also leading to lower sales and therefore negatively affects profitability. Any improvement in sanitation and temperature control usually lowers bacterial count and lengthens retail shelf-life. A more recent innovation (Liu, et al., 1995) is the feeding of vitamin E to feedlot beef to increase the tissue tocopherol content. This practice produces beef which has greater reducing potential and therefore pushes the reaction away from the oxidized brownish metmyoglobin and toward the reduced oxymyoglobin state on the retail cut surface. If the retail packaged beef maintains a desirable bright red color for a longer period, more inventory can be displayed which leads to increased sales.

Objective: To use image analysis to objectively quantify and compare color deterioration on the visible surface of control and vitamin E beef retail loin steak surfaces.

Methods

Thick (3-5 cm) loin strip (New York style) steaks were purchased at Scolari's Supermarket in Reno and Sparks, Nevada USA. Steaks were selected by visual inspection to be as close as possible to the anterior end of the loin (13th rib section). These steaks were selected during the weeks when either control or vitamin E fed beef was available in the stores participating in a vitamin E study. The most recently processed steaks were selected as indicated by the package code date. Degrees of marbling ranged from slight to moderate when compared to USDA color marbling standards.

The loin strip steaks (N=16) were bisected into 2 thinner steaks using a sterilized butcher knife. The resulting steaks were repackaged supermarket style in Styrofoam trays with oxygen permeable film overwrap. The two steaks were packaged such that the original displayed "store" surface was visible in one steak and the "fresh" cut (sterilized knife) surface in the second steak. This produced 32 steak surfaces for evaluation from 8 control and 8 vitamin E thick steaks.

The steaks were photographed with 160T Kodak slide film under 3400 K lighting conditions on a copy stand using an 18% gray card to adjust the F stop. The steaks were photographed 1, 2, 3, 4, and 5 days post purchase. An HP ScanJet 3c scanner with a slide scanner top was set at 1.8 gamma and 300 dpi to scan TIF images (ca. 325K) from slides to a Zip disk. The images were imported into IPLab, (Signal Analytics Corp. Vienna, VA, USA) on a Macintosh Power PC platform.

black background. The images were converted from the RGB format to the CMY format. After comparison to the actual image, it was found that segmentation of the cyan image could very closely approximate the lean and discolored areas by adjusting the width of the gate by using the histogram function. The lean area (red pixels) could be approximated very closely on the cyan split image by using a minimum between 50 and 75 and a maximum of 190. The discolored meat surface area was matched by a setting of 110 minimum and the same 190 maximum. The settings are different from the first report (Ringkob, 1996) due to a gamma of 1.8 for the scanning versus no gamma setting for the first scanning process. Examples of the images produced were combined (Fig. 1) using the mosaic subroutine in IPLab. The number of discolored pixels was divided by the number of lean pixels in the ROI to calculate the percent discoloration shown in Fig. 2.

Results and Discussion

The control and vitamin E steaks discolored at drastically different ($P<.01$) rates as can be seen in Fig. 1 and 2. There was hardly any discoloration in the loin strip steaks from the vitamin E fed beef whereas all of the control steaks had to be discounted or discarded by day 5. When comparing the vitamin E steaks to even the control steaks with little or no discoloration at day 1, there was still an advantage in favor of the vitamin E because of the slightly brighter more uniform color. There was an interaction between vitamin E treatment and processing method (fresh cut vs. store surface). The vitamin E beef had almost no discoloration in either processing method. However, the "store" cut surface discolored more rapidly than the "fresh" cut surface in the control steaks.

Conclusions

Image analysis can map and quantify retail beef discoloration. Vitamin E beef has superior shelf-life when compared to control beef.

Acknowledgments: Support was provided by Hoffmann-LaRoche, Nutley, NJ, USA and Basel, Switzerland.

Pertinent Literature

Liu, Q., Lanari, M.C. and Schaefer, D.M. 1995. A review of dietary vitamin E supplementation for improvement of beef quality. J. Anim. Sci. 73:3131-3140.

Ringkob, T.P. 1996. Image analysis to measure color changes in fresh retail beef steaks. Proceedings of 42nd International Congress of Meat Science and Technology, Lillehammer, Norway. pp. 264-265.

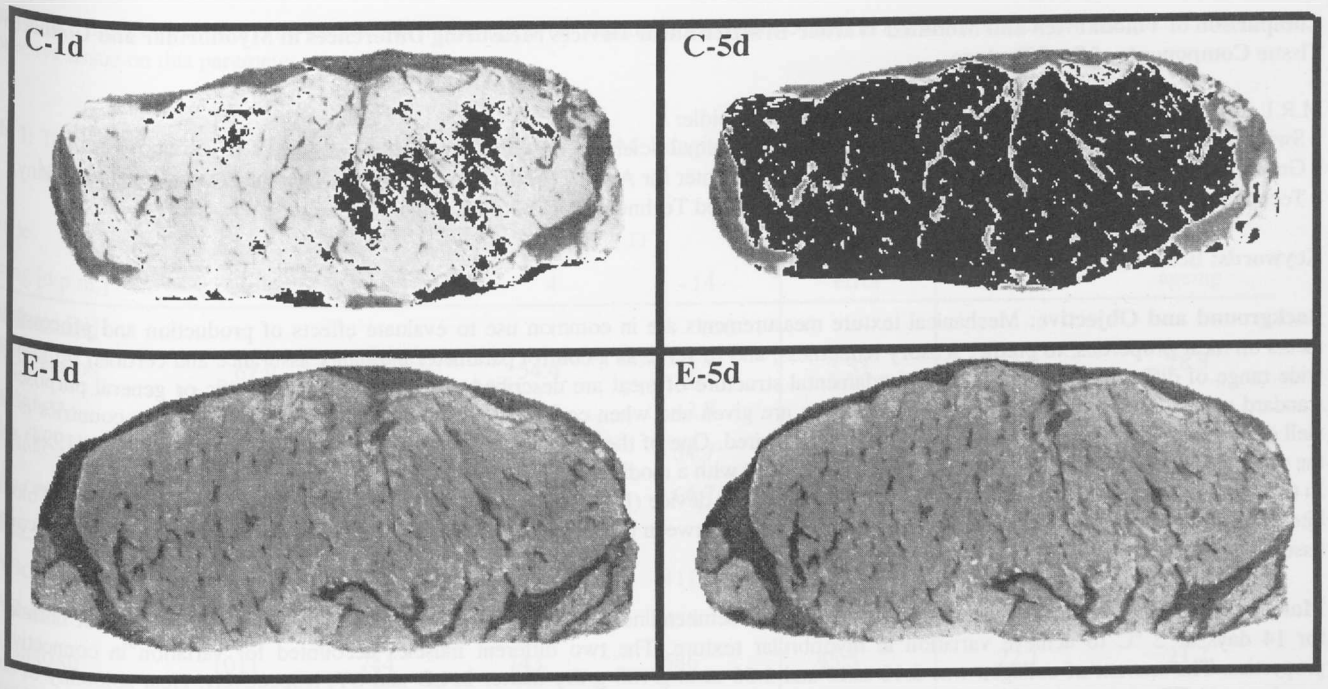

Figure 1. Comparison of control and vitamin E loin strip steak discoloration patterns at 1 and 5 days. The discolored pixels are black.

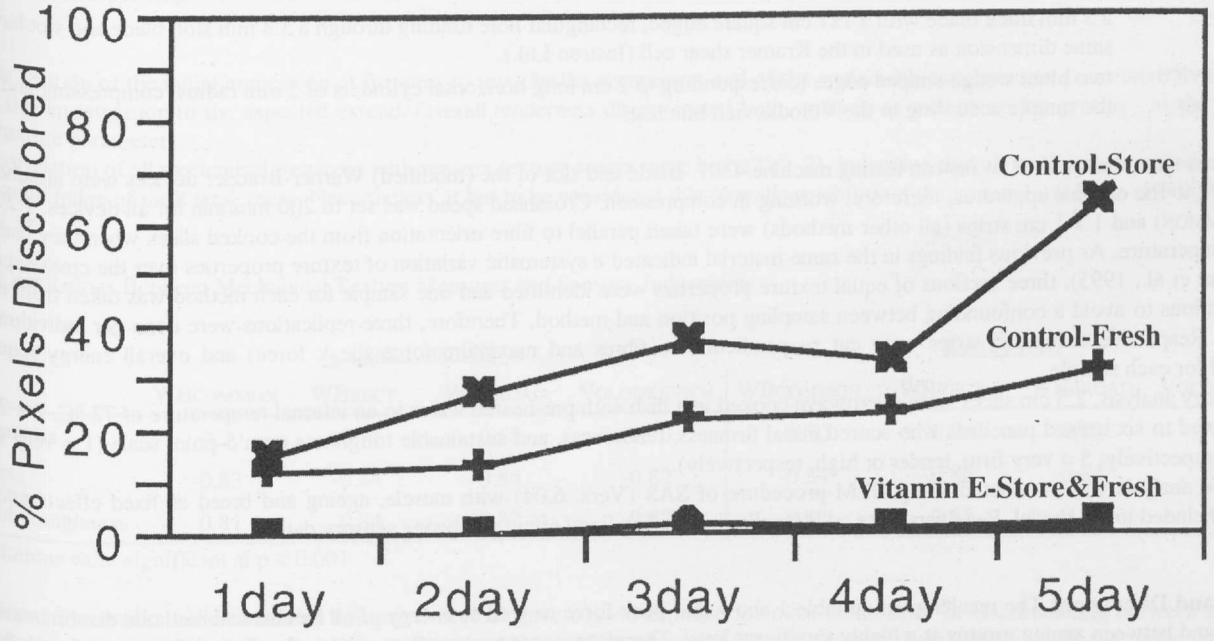

Figure 2. Percent of lean discolored on loin strip steak due to vitamin E and retail treatment.