Using Image Analysis for Meat Color Evaluation

Thomas P. Ringkob

Introduction

One is constantly bombarded with advertising stressing that this store or supermarket chain has the freshest products. For most shoppers, freshness at the point of purchase is more important than taste, nutrition, less fat, etc. The color of fresh meat, especially beef, is the primary way the shopper evaluates freshness. Color is almost always the first sensory characteristic that a shopper evaluates when purchasing fresh meat at a self-service case. If the cut of meat doesn't clear this first hurdle, there is no sale.

Because color is of paramount importance, it has received the attention of the food industry and numerous investigators. There have been many reviews on color and meat (Hunt and Kropf, 1987; Cornforth, 1994). Meat color has also been the subject for many presentations at this conference (Hunt, 1980; Kropf, 1980; Kropf et al., 1984). The "Guidelines for Meat Color Evaluation" (Hunt et al., 1991) has been a valuable source of information to encourage uniformity in collecting color data.

Communicating information and color measurements among scientists is difficult and almost impossible to the meat market manager using a system such as Lab-values. While working with meat market managers, they had two color points. One was when you discounted a fresh beef cut due to discoloration and the other was when you discarded the retail cut because it was no longer saleable. This problem of measuring and communicating color to butchers got me to wondering if there wasn't a better way to measure and communicate color changes to industry. I had become familiar with an image analysis program, IPLab (www.scanalytics.com) while working with Dr. Marion Greaser at the University of Wisconsin. We were recording images from a microscope using IPLab. I started to study the ability of the software to manipulate color images in the TIFF format. I found that the RGB (red, green, blue) could be transformed into HSV (hue, saturation and value), CMY (cyan, magenta and yellow) and two other formats. After much trial and error, the cyan channel seemed to map the discolored (brown metmyoglobin) areas quite well. This may be due to the fact that the CMY mode is a subtractive model whereas the RGB mode is an additive color model.

The files must be in the bitmap or rastor format, which are comprised of rows and columns of pixels in grid-like arrangement. Images in a TIFF format work quite well because each voxel (a pixel with volume) can be measured by the image analysis software. A voxel actually has three numbers, RGB, for example. A segmentation or sorting operation is used to put a color overlay on the image, such as red for the lean areas and green for the discolored areas. The IPLab software has a measurement subroutine, which can record the pixel count of each segment or color. The ratio or percent discolored areas can be illustrated with an image.

Methods

Thick (3-5 cm) loin strip (New York) steaks were purchased at local supermarkets in the Reno and Sparks, Nevada area. Steaks were selected by visual inspection to be as close as possible to the anterior end of the loin (13th rib section). Degrees of marbling ranged from slight to moderate when compared to USDA color marbling standards. The loin strip steaks were bisected into two thinner steaks using a decontaminated 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 surface in the second steak.

The steaks were photographed with 160T Kodak slide film under 3400K lighting conditions on a copy stand using an 18% gray card to adjust the F stop. An HP ScanJet 3e scanner with a slide scanner top was set at 1.8 gamma and 300dpi to scan TIFF image (ca. 325K) from slides to a Zip disk. The images were imported into IPLab on a Macintosh Power PC platform. It is very important to use a top of the line monitor for image analysis.

The steak in the image was traced and the region of interest (ROI) was placed on a black background (Figure 1). The images were converted from the RGB to the CMY format. After comparison to the actual image, it was found that the segmentation of the cyan image could very closely approximate

T. Ringkob
Animal Biotechnology-202
University of Nevada
Reno, NV 89557
tringkob@scs.unr.edu

Proceedings of the 54th Reciprocal Meat Conference (2001)

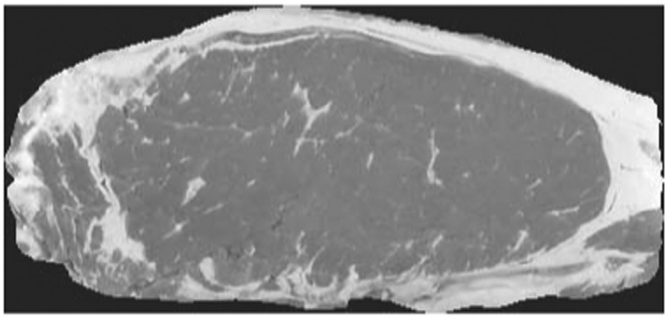

FIGURE 1. *ROI produced by tracing the region of interest with a mouse, copying the ROI (24-bit color) and pasting into a new window.*

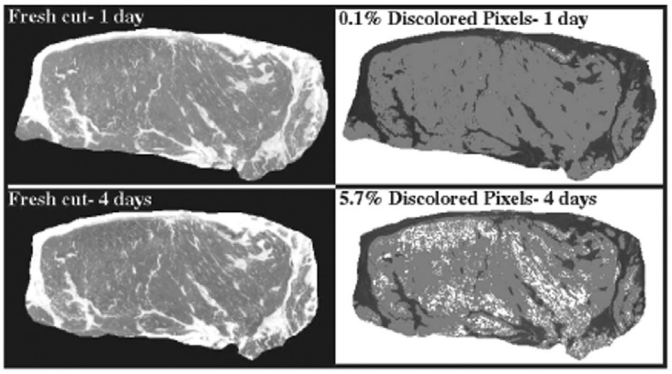

FIGURE 3. *Montage of 1 and 4-day display beef steaks paired with segmented images illustrating discolored pixels.*

the lean and discolored areas by adjusting the width of the gate by using the histogram function. The lean areas (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 setting a 110 minimum and the same 190 maximum (Figure 2). The number of discolored pixels was divided by the number of lean pixels in the ROI to calculate the percent discoloration.

Results and Discussion

This work has been reported in two previous presentations (Ringkob, 1997; Chiang and Ringkob, 1999). The image analysis results tracked the visual changes when comparing the rate of discoloration in control and vitamin E steaks. When color montages were shown to meat market managers, there was a very positive reaction in that they could see the differences (Figure 3). Gerrard et al. (1996) reported a study on determining marbling and beef color score using a Microsoft based program.

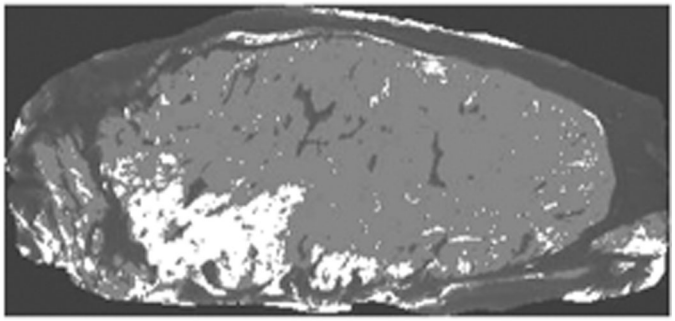

FIGURE 2. *Cyan split color channel from the image in Figure 1, which has been segmented for lean and brownish (light) pixels.*

Future Work

I have only worked with fresh beef. Other meat species, both fresh and cured, need to be evaluated. Color standards were mentioned in the discussion section of Kropf et al. (1984). My suggestion is that we evaluate the use of the Macbeth Color card (www.gretagmacbeth.com) as a color standard since this is used by many professional photographers. Although slides provide a permanent record of color images, some of the new digital cameras would seem to offer some real advantages in ease and speed of capturing images.

Acknowledgments

Financial support was provided by Hoffmann-LaRoche, Nutley, NJ, USA and Basel, Switzerland.

References

Chiang, Y.; Ringkob, T.P. 1999. Effects of cutting method, display temperature and Vitamin E on retail beefsteak discoloration. Proc. West. Sec. Amer. Soc. Anim. Sci. 50:7-10.

Cornforth, D. 1994. Color: Its basis and importance. In A.M. Pearson & T.R. Dutson, Quality attributes and their measurement in meat, poultry and fish products. Advances in meat research series (pp. 35-77). Glasgow: Blackie Academic & Professional.

Gerrard, D.E.; Gao, X.; Tan, J. 1996. Beef marbling and color score determination by image processing. J. Food Sci. 61:145-148.

Hunt, M.C.; Acton, J.C.; Benedict, R.C.; Calkins, C. R.; Cornforth, D.P.; Jeremiah, L.E.; Olson, D.G.; Salm, C.P.; Savell, J.W.; and Shivas, S.D. 1991. Guidelines for meat color evaluation. Proceedings 44th Reciprocal Meat Conference. Appendix pp. 1-17.

Hunt, M.C. 1980. Meat color measurements. Proceedings Reciprocal Meat Conference. 33:41-46.

Hunt, M.C.; Kropf, D. H. 1987. Color and appearance. In: Adv. Meat Research. Vol. 3. Restructured Meat and Poultry Products (pp. 125-159). AVI Publishing Co., Inc., Westport, CT.

Kropf. D.H. 1980. Effects of retail display conditions on meat color. Proceedings Reciprocal Meat Conference. 33:15-32.

Kropf, D.H.; Olson, D.G.; and West, R.L. 1984. Objective measures of meat color. Proceedings Reciprocal Meat Conference. 37:24-32.

Ringkob, T.P. 1997. Image analysis to quantify color deterioration on fresh retail beef. ICOMST 43:688-689.