IMAGE ANALYSIS TO MEASURE COLOR CHANGES IN FRESH RETAIL BEEF STEAKS

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Background

The first hurdle that must be surmounted in the selection of retail beef from a self-service case in the USA is desirable color. Depending on the shopper, if the color is subnormal from their standpoint, there is no sale. Color anomalies with fresh beef, such as dark or discolored steaks, cost American supermarkets more than any other fresh meat problem according to meat department managers. Color problems usually fall into two categories; 1) dark color due to high pH beef from pre-slaughter stress and beef from older animals which retains its darker purplish color during retail display and 2) discoloration (brownish metmyoglobin) within 1 to 2 days of retail display thought to be associated with surface bacterial action. The dark beef generally never reaches the retail supermarket because of consumer discrimination so it enters different distribution channels.

The delay of fresh retail beef steak discoloration by even 1 to 2 days would be an important economic improvement for fresh beef retailers. There would be far fewer retail mark-downs and reworks which are both costly to the USA beef industry.

Objective: To determine color characteristics and especially discoloration of retail fresh beef using computer image analysis.

Methods

Thick (3-5 cm) loin strip (New York style) steaks were bought at a number of supermarket locations in the Reno and Sparks, Nevada, USA area. Steaks were selected by visual inspection to be as close as possible to the anterior end of the loin (13th rib section) if they were available in the retail self-service meat case. 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=24) 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 original displayed "store" surface was visible in one steak and "fresh" cut surface in the second steak. This produced 48 steak surfaces for evaluation from the 24 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 samples were photographed at approximately 4 hours post purchase and every 24 hours (28, 52, 76) for 3 days. An HP ScanJet 3c scanner was used to scan TIF images from slides on to a Zip disk. The images were imported into IPLab (Signal Analytics Corp., Vienna, VA, USA) on a Macintosh Power PC platform. This system uses the Macintosh operating system rather than the Microsoft C system (Demos et.al., 1995 and Gerrard et al., 1996).

The color images were displayed on the computer screen. 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 red and discolored areas by adjusting the width of gate using the histogram function. This was converted to associated pixels to percent of region of interest (ROI). An experienced meat department manager scored the steaks as to probable and definite pull dates. These ratios of discolored to red pixels were compared to meat managers color evaluations to fine tune the system.

Results and Discussion

An ROI was produced on the computer screen by using a free-hand tool to trace the steak outline and was copied to a black background. The red pixels (lean area) were produced on the cyan split image by using a minimum of 125 and a maximum of 195. The discolored pixels were represented by a minimum of 165 with the same 195 maximum. Examples of the images are seen in the montage (Fig. 1).

By using a function that calculated the pixels as a percent of the ROI, a ratio of discolored pixels to total red pixels was graphed (Fig. 2). As might be expected all the "store" surfaces were darker than their "fresh" counterpart surfaces or would be pulled sooner by the retail meat manager. The faster color deterioration is probably due to the exposure to bacterial contamination under normal retail operation when compared to the "fresh" cut made with a sterilized knife and handled to minimize bacterial exposure. However, by 76 hours post purchase, the fresh cut surface has discolored to the same degree as the store cut surface (Fig. 2).

It was observed that the fresh cut surface had not fully bloomed at 4 hours post purchase which was at least 1 hour after making the fresh cut surface. In every group of eight steaks there was one or two steaks which showed almost no discoloration after 4 or 5 days. These steaks could be identified at 28 hours because less than 5% of their pixels in the ROI were dark or discolored.

Conclusions

Image analysis can track retail beef surface discoloration. Image analysis shows promise to obtain permanent and reproducible results from fresh meat samples.

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Pertinent Literature

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Gerrard, D.E., Gao, X., and tan, J. 1996. J. Food Sci. 61:145.

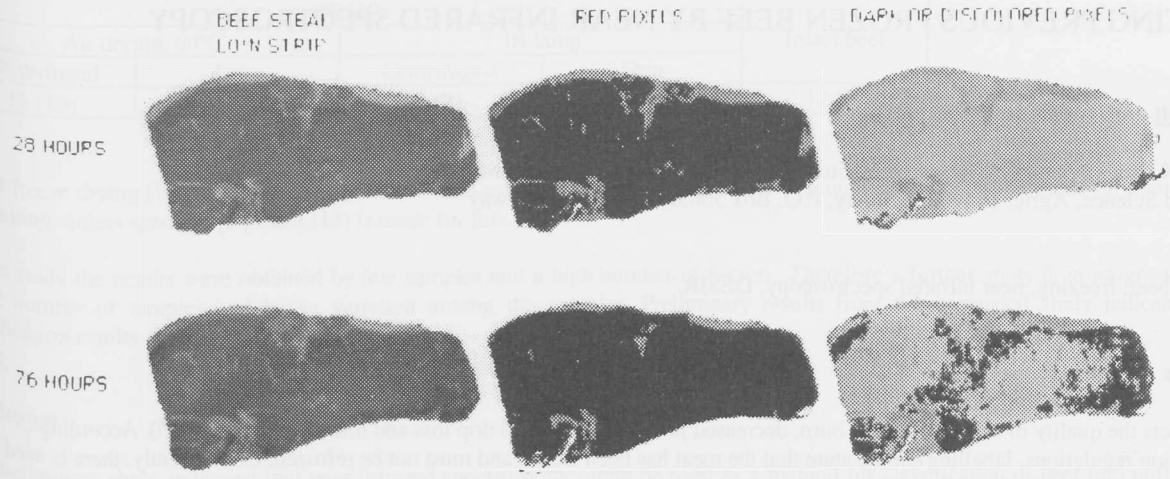

Figure 1. Montage of images produced from the ROI of a loin strip steak

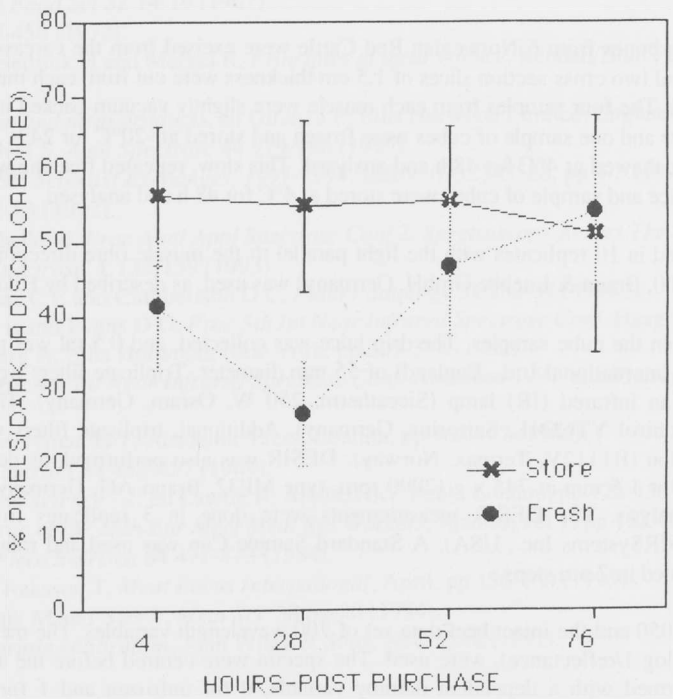

Figure 2. Changes in dark or discolored pixels as a percent of red pixels over a 3 day period.