PE3.08 Continuous Monitoring of the Blooming Process in Freshly cut Pork and Beef using an Imaging Spectrometer 351.00

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***Abstract* - In order to measure the duration of the blooming process in meat, a range of experiments have been performed. Freshly cut meat samples from pork *Biceps Femoris* and *Longissimus Dorsi* and from beef *Semimembranosis* were each measured using an imaging spectrometer (Videometer Lab) from the company Videometer. This instrument is capable of registering a spectrum at 20 discrete wavelengths in the range from 400nm to 1050nm. A standard Sony camera (1280x960 pixels) was used as detector. The camera was located relative to the sample in such a way that the instrument was capable of acquiring more than 1 million spectra from sample areas of approx. 90 x 90 microns. After initial cutting, each meat sample was measured with the Videometer Lab every 5 minutes for a period of 90 minutes. Between measurements the samples were cold stored at 4°C. From the acquired spectra it was now possible to calculate the relative change in the Oxy-Myoglobin content at the surface layer of the samples. The results demonstrate that for beef samples, the blooming process continues for as long as 60 minutes. For the pork loin samples, blooming was fully developed after only 10 minutes.**

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***Index Terms* - Beef, Blooming, Colour, Myoglobin, Pork, Spectral Imaging.**

I. INTRODUCTION

The process of blooming and colour development after packaging is of interest to the meat industry and to food retailers as consumer preferences for meat are strongly influenced by appearance. In order to evaluate and compare the colour of meat and other categories of food it is necessary to have an instrument capable of producing objective measurements of the surface of a sample. It is a strong advantage if the instrument is able to measure colour, chemical composition and structure at the same time. The imaging ability of the instrument makes it possible to use standard imaging analysis techniques, e.g. to discard pixels with intramuscular fat. In this way, we can ensure that only the lean meat is sampled.

The Videometer Lab [1], depicted in Figure 1, has all of these properties. The instrument consists of a standard Sony camera with a resolution of 1280x960 pixels, an integrating sphere with light diodes of 20 different wavelengths placed inside.

The 20 wavelengths are: 430nm, 450nm, 470nm, 505nm, 525nm, 565nm, 570nm, 590nm, 630nm, 645nm, 660nm, 700nm, 850nm, 870nm, 890nm, 910nm, 920nm, 940nm, 950nm, 970nm.

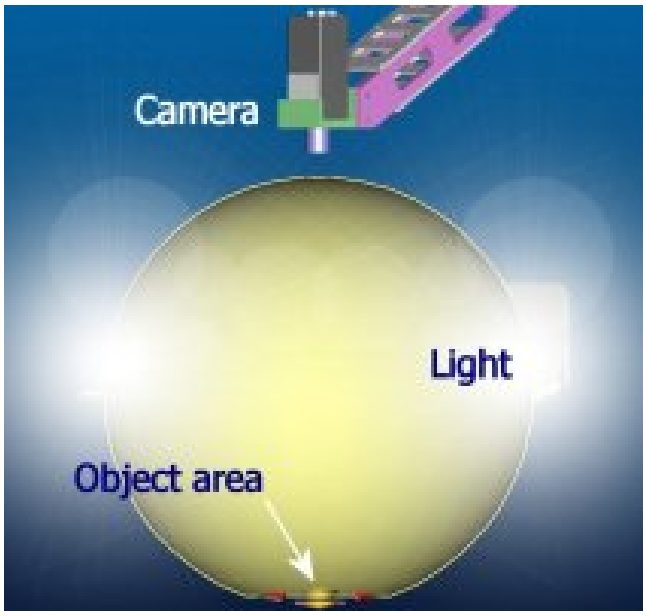

Figure 1.

The sample is placed under a round opening (r=12 cm) at the bottom of the sphere. The light diodes are flashed one at a time resulting in the sample being diffusely illuminated. Each time the sample is illuminated with a new wavelength an image is acquired. The resulting measurement consists of 20 1280x960 pixel grey scale images. Thus, each pixel in the images represents a reflectance spectrum at 20 wavelengths.

II. MATERIALS AND METHODS

Prior to use, the instrument is calibrated using a white and a dark reference plate supplied by the manufacturer. The absorbance values A obtained

hereafter are all calculated relative to these two reference plates and are derived as A = -log(R) where R is the reflectance at a given wavelength.

Moderately matured [2] *Semimembranosis* muscle from beef, and pork *Biceps Femoris* and *Longissimus Dorsi* were used in the study. The sample temperature was 4°C. From each muscle, three 4 cm thick slabs were cut perpendicular to the fibre directions. After cutting, each sample was immediately placed under the Videometer Lab and a measurement was performed. After measuring, the samples were returned to the 4°C cold storage. At intervals of 5 minutes, the samples were retrieved from the refrigerator and measured again with the Videometer Lab.

This procedure was repeated for 90 minutes and afterwards the entire data collection consisted of 3 x 3 x 19 sets of spectral images corresponding to the three muscles, three subsamples from each muscle and measurements of 19 time intervals from 0 minutes to 90 minutes after the cut was made.

As a measure for the formation of Oxy-Myoglobin during blooming we have chosen to use the relationship:

$$[\text{Oxy-Mb}] = k \times (R_{630+} R_{645}) / (R_{470+} R_{565})$$

Which can be interpreted as the ratio between reflection values in the red and the blue-green parts of the spectrum. K is an undetermined constant.
Alternatively, relationships found in the literature were tested

$$[\text{Oxy-Mb}] = -4.77A_{635} + 37.31A_{581} - 26.29A_{657} \quad [3]$$

$$[\text{Oxy-Mb}] = (0.88A_{572} - 1.27A_{565} - 0.81A_{545}) / A_{525} + 0.015 \quad [4]$$

However, the last two equations did not give results that could be meaningfully interpreted.
It should be noted that the Oxy-myoglobin calculated in this way are in arbitrary units. This is due to the arbitrary choice of reference tiles used by the instrument manufacturer.

III. RESULTS AND DISCUSSION

I figures 2a and 2b are shown two raw images from the beef *Semimembranosis* muscle at 430nm and at 565nm obtained immediately after cutting (t=0 min). In figure 2c a reconstructed colour image of the same sample is shown.

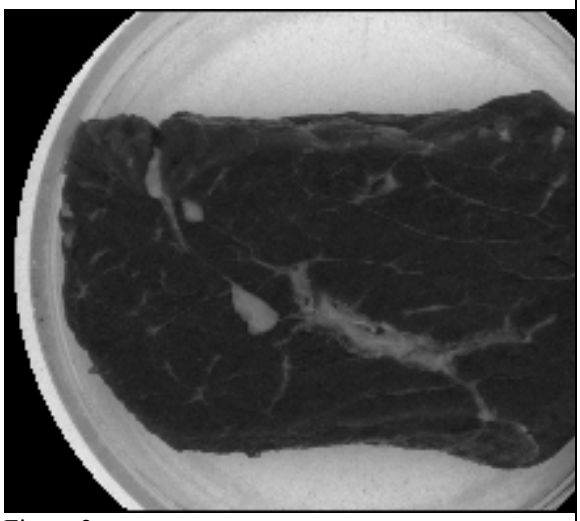

Figure 2a

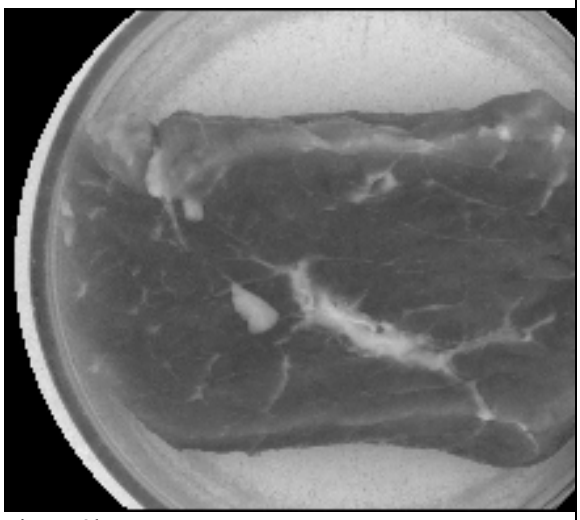

Figure 2b

Figure 2c

Figure 3 shows how the meat spectra evolve during blooming. For simplicity, spectra of the beef samples are shown at times: t = 0 min, t = 10 min and t = 60 min after cutting. We see that the reflectance is constant below 550nm but that the reflectance increases in the yellow and red wavelengths during blooming. Notice, that the reflectance at 565nm is constant with time. This means that the L^* value is independent of the period for which the sample has been blooming [5].

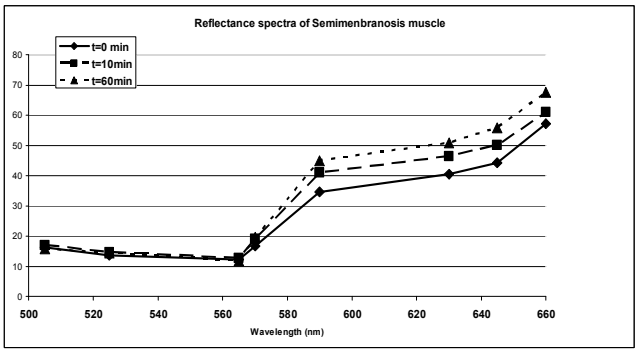

Figure 3:

A quantified view of how the Oxy-myoglobin content increases during blooming can be seen in figures 4a *Semi Membranosis* (SM) beef and 4b for pork loin (LD) and pork *Biceps Femoris* (BF).

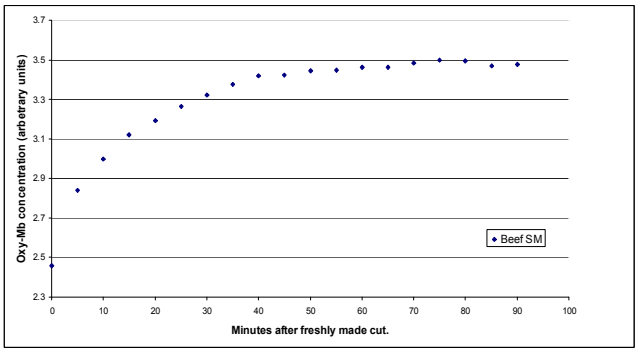

Figure 4a

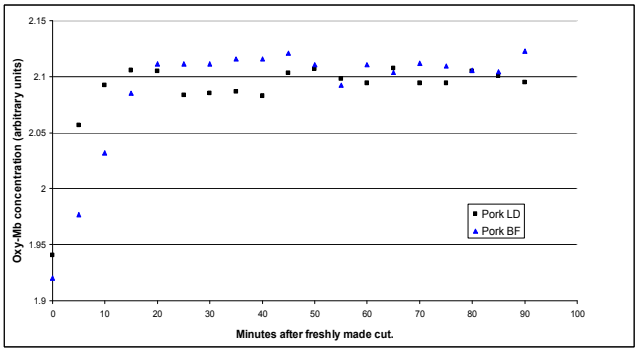

Figure 4b

The measurements shown here (especially figure 4a) are typical examples of a chemical system gradually coming to equilibrium with its surroundings.

Notice that the duration of the blooming process is much greater for beef than for pork (60 minutes and 10-15 minutes respectively).

IV. CONCLUSION

It is demonstrated that the process of blooming in beef is not completed before 60 minutes after exposure to atmospheric oxygen. However, in pork the blooming process is much faster and is completed within the first 10 to 20 minutes which is in general agreement with Brewer et al.[5]. The results of this study provides some indication that the *Biceps Femoris* muscle requires almost twice as long a time for blooming as the *Longissimus Dorsi* muscle, 10 and 20 minutes respectively.

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