EVOLUTION OF VEAL COLOR OVER TIME AND PARAMETERS INVOLVED IN THE PREDICTION OF REFLECTANCE VALUES FOR THE PURPOSE OF GRADING CARCASSES

S.A. POMMIER, B. LACHANCE, C. VINET
Agriculture Canada, Research Station, Lennoxville, Quebec, Canada J1M 1Z3

SUMMARY: This study demonstrates that veal color gets paler with time postmortem. Grain fed veal reflectance values reached a peak at four days postmortem. The increase was substantial and reached an average of 10 reflectance units between day 1 and day 4 postmortem. The optimal blooming time of the meat prior to taking a color measurement was found to be 20 minutes. Relatively, good correlation existed between the reflectance of the different locations studied indicating that the pectoralis major muscle was a good indicator of overall carcass color. Meat from milk fed veal was whiter than meat from grain fed veal but it also got paler with time. Large variations existed in the population that we studied and increases in reflectance with time postmortem varied from a minimum of 7 units up to a maximum of 38 units. It was concluded that grading time must be at a fixed time point in order to assess carcass color accurately and use reflectance for comparative purposes.

INTRODUCTION: One of the most important quality aspects of veal is the color of the lean. Consumers who are willing to pay more for quality veal will inevitably purchase a light colored product. The myoglobin content of veal meat is a major factor determining the color of the meat. Traditionally white veal has been milk fed to provide a low iron diet. In recent years the canadian market has been confronted with grain fed veal which is darker in color due to the inherently higher iron content of the animals diet. In order to classify veal and to financially compensate for quality veal the canadian grading system has provided a reflectance measurement of the pectoralis profundus (P) muscle of the carcass. This has resulted in four classes of meat graded according to the reflectance value. Hence, within each conformation class there are 4 color classes. Class 1: $R>50$; Class 2: $40\leq R\leq 49$; Class: $30\leq R\leq 39$; Class 4: $R<30$.

The objective of this work was to measure the change in color of veal meat postmortem, to determine at which time point the color stabilizes and to correlate color measurements made at different locations and at different time points.

MATERIALS AND METHODS: Experiment 1. Eighty-three grain fed male Holstein veal calves were slaughtered at 215 kg liveweight. The carcasses were dressed hide on, stored at 1°C and color measurements were taken with an Agriculture Canada grading reflectance meter (Brach et al., 1987). The readings obtained with the unit are in lux units (Y). Reflectance was taken on days 1, 2, 3, 4 and 7 postmortem on the pectoralis major (P). The measurement was made on an exposed portion of the muscle proximal to the sternum perpendicular to the muscle fibers. A fresh cut was made at the same location on each day of measurement by taking a 5 mm slice off the surface. Bloom was evaluated on day 2 by taking measurements 0, 10, 20, 30 and 40 min after the cut was made. After seven days in the cooler, the carcass was cut between the 6th and 7th rib and a reflectance measurement was taken on the longissimus dorsi (LD_6), in addition the hind quarter was broken off and a measurement was taken on the exposed longissimus dorsi (LD) and the psoas major (PM). Also a color reading was taken on the semimembranosus muscle (SM) proximal to the tuber ischii. A bloom time of 20 minutes was allowed for measurements taken on locations other than the brisket.

Experiment 2: In this experiment we had 95 commercially available milk fed male Holstein calves which constituted a heterogenous population for which the slaughter weight averaged 187 kg. Dressing and storage of carcasses were done as described in experiment 1. Color measurements were performed on the P with the grading colorimeter 45 minutes postmortem and at three days postmortem.

RESULTS AND DISCUSSION: The evolution of color over time is shown on Figure 1 for grain fed veal (Experiment 1). Between day 1 and day 4 a 10 degree increment in the Y value was observed. At day 4 the reflectance seemed to attain a maximum and then started to decline going towards day 7. This increase in paleness overtime therefore had a tremendous impact on the grading of the carcasses and certainly implied that a fixed time point had to be chosen in order to classify carcasses with respect to reflectance values. Our results tend to complement data demonstrating an increase in paleness in the first 24 hrs postmortem (Swatland, 1985).

The effect of oxygen equilibration with the meat pigments is shown in figure 2. Measurements were taken every 10 minutes for up to 40 minutes after the cut was made. The two day readings seemed to demonstrate a levelling off of the reflectance values at 20 minutes. The increase was slight i.e. 2.0 units and may have been affected by surface dehydration. Hence a 20 minute blooming time was recommended as the optimum period before taking an instrumental measurement.

In addition to measuring color at the level of the brisket on the P muscle at day 7, measurements were also made at other locations (Table 1). The palest

Table 1. Summary statistics and location effects of reflectance measurements.

Location	N	Mean	Min	Max	SD
Longissimus dorsi 6th rib (LD_6)	76	50.41[a]	26.00	81.00	9.12
Psoas Major at the level of the sirloin (PM)	77	48.47[ab]	31.50	76.50	8.86
Semimenbranosus (SM)	77	47.78[ab]	26.50	78.50	9.95
Longissimus dorsi sirloin level (LD)	77	46.43[b]	20.00	74.00	9.03
Pectoralis Major Brisket (P)	73	43.59[c]	28.00	71.00	7.58

[abc]Means bearing different superscripts are significantly different ($P<0.05$)

location was measured at LD_6 while the darkest location was found to be the P muscle. The other locations gave intermediate results. Interestingly the LD location was significantly darker than the LD_6 location. Since we should expect a similar muscle composition this observation might indicate that the LD at the

level of the sirloin cooled more rapidly than at the level of the 6th rib. Chilling rate may affect color with rapidly cooled meat being darker in appearance than slowly cooled meat (Renerre and Dantchev, 1987; Smulders and Eikelenboom, 1986). Very big variations were encountered between animals as demonstrated by the minimum and maximum values encountered at the different locations.

Pearson correlation coefficients (Table 2) were used to demonstrate the relationships between measurements made at grading time on the P muscle (day 2) and color of the different locations at day 7, time at which the meat would be merchandised. A high correlation between day 2 and day 7 measurements on the P muscle showed a good predictive value of the day 2 measurement for the same location (r=0.82). Correlations between the P muscle at day 2 and other locations at day 7 were also significant but a bit lower. Interestingly, correlations between measurements made on the P at day 7 and other locations at day 7 were sensibly the same as those found between reflectance of the P at day 2 and that of other locations at day 7. This could indicate a certain stability over time, at least after two days, of the relationship between the reflectance of the P and that of other locations. A relatively low correlation coefficient was found in the reflectance found between the psoas major and the longissimus dorsi at the level of the 6th rib (r=0.53). This could be explained by a two tone appearance seen at this level between the two muscles which seemed to be due to a DFD (dark, firm, dry) condition. In some instances the difference was in the order of 20 units of Y, a difference much too big to be induced by differences in cooling rates.

Table 2. Correlation coefficients[1] demonstrating relationships between time measurements and locations.

Variables[2]	P day 2	P day 7	LD_6 day 7	PM day 7	SM day 7
P, day 7	0.82	1.00			
LD_6, day 7	0.72	0.66	1.00		
PM, day 7	0.63	0.63	0.53	1.00	
SM, day 7	0.62	0.65	0.76	0.67	1.00
LD, day 7	0.67	0.62	0.79	0.56	0.72

[1] All coefficients presented in this table are significant ($P<0.01$)
[2] P - pectoralis; LD_6 - longissimus dorsi, 6th rib; PM - psoas major; SM - semimembranosus; LD - longissimus dorsi, sirloin level.

In experiment 2 we examined the color of white veal carcasses at two time points only (Table 3). The minimum and maximum liveweights as well as the large standard deviation (S.D.) reflect the heterogeneity of the population. Nevertheless it constituted a good population to relate liveweight to lean color variations. The average reflectance values of this group of carcasses was much

higher than in the first experiment (62.42 on day 3, Table 3 vs 41.00 on day 3, Figure 1) and was inherent to the type of diet that the animals received before slaughter. However, the carcasses showed a similar behaviour as to the evolution of color over time. Between slaughter and 3 days postmortem the carcasses gained an average of 22 units of Y and a large variation in color was present between individual animals, as observed with the grain fed veal of experiment 1. The value of the delta in Table 3 revealed that in some instances carcasses did not get much paler. At one end of the spectrum a carcass gained only 7 units of Y while at the other end a 38 unit increment was observed.

Table 3. Summary statistics of reflectance data measured on milk fed veal carcasses. Experiment 2.

	N	Mean	Min	Max	SD
Liveweight (kg)	95	187.53	125.75	230.30	20.36
Reflectance 45 min postmortem	95	40.16	32.00	47.00	2.84
Reflectance day 3 (Pectoralis major)	95	62.42	44.00	85.00	8.86
Delta[1]	95	22.25	7.00	38.00	7.21

[1]Difference between day 3 and 45 min reflectance data.

Table 4. Correlation coefficients between reflectance measurements of milk fed veal.

	Reflectance day 3	Reflectance day 0	Delta
Reflectance day 0	0.69**	1.00	
Delta[1]	0.95**	0.45**	1.00
Liveweight	-0.17	-0.19	-0.13

**P<0.01
[1] Difference between day 3 and 45 min reflectance data.

Correlation coefficients (Table 4) between the delta value and reflectance at 45 min showed a significant positive correlation (r=0.45) indicating that the higher the initial value, the bigger the improvement on meat color. The correlation between delta and the 3 day reflectance reading (r=0.95) was obviously high since the bigger increase in reflectance was translated into a high 3 day reading. This was true only if the reflectance values at slaughter were clustered together. It seemed to be the case since the standard deviation (SD) for the 45 min readings was were much smaller than the SD of the three day readings. A significant correlation (r=0.69) exists between reflectance at 45 min and reflectance at three days but it would probably not be high enough to be useful for predictive purposes. In this data the liveweight at slaughter was not useful in predicting color.

CONCLUSION: The main observation stemming from the present results is the instability of veal color over time. The increase in reflectance, observed up to four days postmortem for grain fed veal is in accord with results obtained by Fortin (1989) which showed that the reflectance of milk fed veal meat reached a peak at three days postmortem. The increase is substantial and can influence grading results depending on how much time the carcasses have been in cold storage. Grading procedures must be revised to accomodate such changes.

REFERENCES:

Brach, E.J., Fagan, W.E. and Raymond, D.P. (1987) Instrument for grading veal carcasses. J. Food Qual. 10:91-99.

Fortin, A. (1989) Personal Communication.

Renerre, M. and Dantchev, S. (1987) Influence of electrical stimulation and carcass chilling mode on lamb meat color stability. Sci. Ali. 7:535-548.

Smulders, F.J.M. and Eikelenboom, G. (1986). Electrical stimulation, cooling intensity and veal tenderness. Fleischwirtsch. 66:883-885.

Swatland, J.J. (1985) Measurement of veal color by fiber optic spectrophotometry. J. Food Sci. 50:1489-1490.

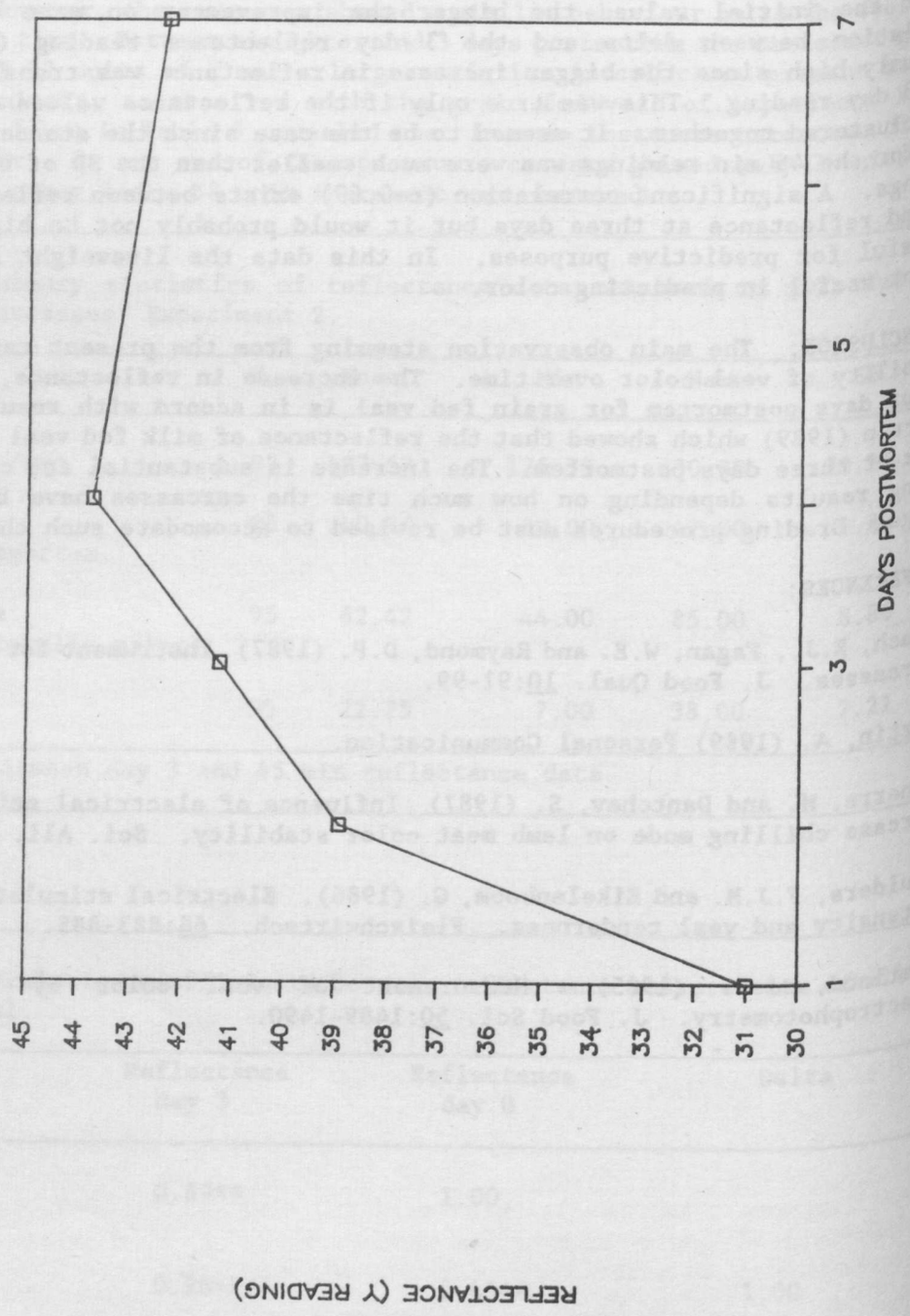

Figure 1: Reflectance measurements of the pectoralis muscle as a function of time postmortem.

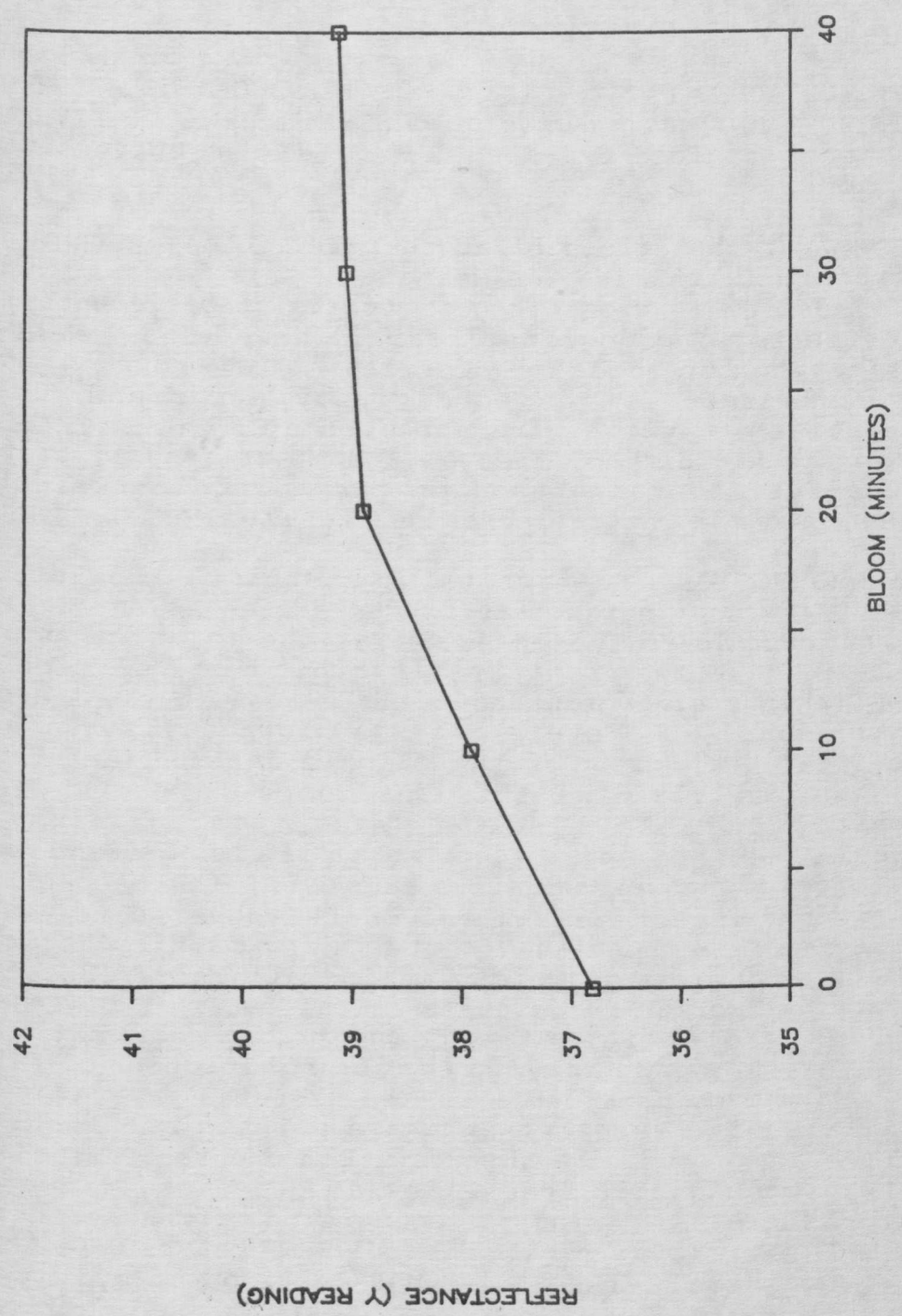

Figure 2: Evolution of bloom over time for different days postmortem.