EFFECT OF ALTERING pH ON THE COLOUR OF STIMULATED AND NON-STIMULATED LOIN MUSCLES FROM 300 DAY GRAIN-FED CATTLE

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BACKGROUND: The colour of meat is dependent upon several factors including the ultimate pH of the muscle, the rate of pH decline and the myoglobin concentration. Generally, it is recognized that an ultimate pH of > 5.8 will produce dark meat, called "dark cutting" meat. Fast pH decline rate will produce pale soft watery meat. High myoglobin concentration in certain muscles and muscles from older animals will result in darker meat. It is a combination of these three factors that determines the final colour of the meat.

Recently we investigated samples of beef loins from 300 day grain-fed cattle that had a high incidence of dark coloured meat. Initial investigations showed that the pH of the meat was < 5.8 so the samples were not classified as "dark cutting". Analysis of 11 loin samples indicated that the dark colour may have been due to slightly elevated pH values (even thought the pH was in the range 5.5 to 5.8). Plots of pH vs colour score showed a curvilinear relationship between colour score and pH with a correlation coefficient of 0.89. In order to further understand the problem an additional 8 samples were analysed but the trends observed initially were no longer apparent. As a follow-up to this earlier research, we have designed an experiment to artificially elevate the pH of post-rigor striploin samples and then measure the effect this has on the meat colour.

AIM: The aim of this work was to study the effect of changing the pH of both stimulated and un-stimulated striploins from 300 day grain-fed cattle (in the pH range 5.20 to 6.50) by injecting Sodium Hydroxide (NaOH) to increase the pH and Hydrochloric Acid (HCl) to decrease the pH and then assess the colour of the meat samples using a trained colour panel and a Minolta Chroma Meter.

MATERIALS AND METHODS

Samples Vacuum packaged striploins from the left and right side of three 300 day grain-fed cattle (36-48 month old, Angus X) were obtained four days post-mortem from cattle that had been slaughtered at a commercial slaughter-plant. The striploins were from cattle that had been either not electrically stimulated or stimulated for 20 seconds. The pH was determined on each loin using a glass pH electrode and all values were in the normal pH range (5.54 - 5.59). The treatments were as follows: **A.** Non-stimulated, pH 5.57, AusMeat colour score 3; **B** Non-stimulated, pH 5.54, Ausmeat colour score 1C; **C** Stimulated, pH 5.59, AusMeat colour score 1B.

pH Adjustment The striploins were cut into 6 x 5.0 cm thick steaks and all fat and connective tissue was trimmed and the muscle was weighted to determine the amount of 2.0M NaOH or 2.0M HCl to be injected. For each 100g of muscle the amount of NaOH or HCl was calculated using the equation from previous research by Trout (1999): Wt 2.0M NaOH or HCl (g) = Delta pH (change in pH) x 7.6 The pH of the striploin was adjusted to 5.25, 5.50, 5.75, 6.00, 6.25 and 6.50 using either NaOH or HCl and the volume of solution added was 10% by weight. The initial pH of the sample was 5.54-5.59 and using the equation above and the weight of each sample the required volume of 2.0M NaOH or HCl solution and water to obtain the final pH values was calculated. The solutions were injected into the steaks in a grid pattern with injection sites approximately 2.0 cm apart using a 9 gauge needle and 60ml plastic syringe. The needle was inserted to a depth of approximately 2.0 cm into the first side of the steak and the solution was injected slowly as the needle was withdrawn. When the first side was completed the samples was turned over and the other side injected. Immediately after injection the steak was placed into a cryovac bag with the excess solution and vacuum packed and then placed in the temperature control cabinet (0°C) for 48 hours.

pH and Colour Assessment. After 48 hours each sample was cut in half and trimmed to give two steaks that were approximately 2 cm thick. Each steak was placed onto a labeled polystyrene tray and covered with cling wrap and allowed to bloom for 2 hours prior to colour assessment by sensory panel (8 panelists) for AusMeat colour score (1A=Very Pale Red 8=Very Dark Red) and measurement of L*, a*, and b* using a Minolta Chroma Meter (mean of six readings). After colour assessment, the pH of the steaks was determined using the probe electrode (mean of 6 readings per side) and also by the homogenisation method (10g of muscle homogenised with 100g of 1.0% saline).

RESULTS AND DISCUSSION

pH Adjustment Altering the pH of the striploins using the prediction equations previously developed from loins from lighter weight cattle produced the predetermined pH levels (5.2 to 6.5) for all three treatments. However, with the highest pH (6.5) the stimulated loin had a pH slightly lower value than predicted (6.39) and the two un-stimulated loins had a slightly higher pH than predicted (6.61 and 6.69). But essentially the predetermined pH values were obtained for the three different loin treatments.

Effects on Colour The graphs for the change in AusMeat colour scores, averaged over left and right side, for the stimulated and un-stimulated loins are shown in Figure 1-3. These results show that the stimulated and non-stimulated loins responded very differently to changes in pH. With the two unstimulated loins (A&B), the colour score was low (2.0 - 3.0) and reasonably constant between pH 5.25 and 5.80 and then increased fairly rapidly from 5.80 to 6.50 to a maximum AusMeat colour score of 4.5-5.5 at pH 6.50 (Fig 1&2). With the stimulated loin (C, Figure 3) the AusMeat colour score changed little with increasing pH over the whole pH range - it went from a colour score of 1.3 (1a) at pH 5.25 to a colour score of just over 2.0 at pH 6.50.

The Minolta colour values (L*, a*, and colour intensity) showed a similar pattern of change in colour with increasing pH as was seen with the AusMeat colour scores, except the pattern was reversed i.e., the values stayed constant at low pH and decreased with increasing pH (Fig. 4-6). The reason for the reversed pattern of change of tristimulus colour values with pH compared to the visual colour scores is that the tristimulus

colour values decrease as the meat becomes darker not increase as is the case with AusMeat colour score. In reality, both the AusMeat colour scores and the Minolta colour values showed a similar trend in change in colour with change in pH, this is, they both show that the meat becomes less red but darker as the pH increases. The tristimulus L* values for all three loins showed a similar linear decrease in value with increasing pH (Data not shown). The main difference was that the L* values for the stimulated loin was much higher than for the two non-stimulated loins indicating that the stimulated loin was lighter and hence would have a lower colour score than the two non-stimulated loins. There was considerable difference in the change in a* value with increasing pH between the non-stimulated and stimulated loins (Data not shown). With the non-stimulated loins, the a* value changed little with the increasing pH from 5.20 to 5.80 and then decreased moderately rapidly as the pH increased from 5.80 to 6.60. With the stimulated loin, the a* value changed very little with increasing pH over the pH range studied. The trend in change in a* value with increasing pH for the three different loins is similar to that observed with AusMeat colour scores.

Colour intensity (L*+a*+b*) showed very similar changes in value with increasing pH to that observed with AusMeat colour score (Figure 4-6). The two stimulated loins high colour intensity values at low pH (i.e., were lighter), the values changed little between pH 5.20 and 5.80 and then the values decreased (i.e. became darker) reasonably rapidly between 5.80 and 6.70. In contrast, with the stimulated loins, the colour intensity was higher (i.e., the colour was lighter) at low pH and changed little with increasing pH.

Relationship between AusMeat Colour Score and Minolta Chroma Meter colour measurements. A further practical consideration with this study was to determine if the Minolta Chroma Meter could be used as a replacement for visual colour assessment and if it could accurately predict AusMeat colour score. The graphs of Minolta colour measurements versus AusMeat colour score (Data not shown) indicated that there is a very good relationship between L*,a*, colour intensity and the AusMeat colour score over the range of colour scores 1b-5. Of the three measurements, colour intensity could most accurately predict AusMeat colour score (R^2= 83.7%).

CONCLUSION The results from this research show that the pH of loins from both stimulated and non-stimulated 300 day grain-fed cattle can be adjusted to predetermined levels between 5.20 and 6.50 by injecting different concentrations of 2.0M NaOH or HCl. The change in colour of the loins with increasing pH from 5.2 to 6.5 as assessed by AusMeat colour score and Minolta Chroma Meter (L*, a* and colour intensity) varied between the non-stimulated and stimulated loins. With the non-stimulated loins, the colour changed very little between 5.20 and 5.80 and then increased fairly rapidly between 5.80 and 6.50 to final colour scores between 4.5 and 5.5. With the stimulated loins, the color was low (1.3) at pH 5.2 and increased only slightly (to 2.0) as the pH increased to 6.50. Hence, the results from this study show that loins from these electrically stimulated cattle will not be 'dark cutting' even if the pH is high (greater than 5.80). The research also showed that the colour measurements from Minolta Chroma Meter where highly correlated to AusMeat colour score. Colour intensity measured by the Chroma Meter could predict AusMeat colour score over the range 1b to 5.0 with an accuracy of 83.7%. Hence, the Chroma Meter could potentially be used as a routine quality control instrument for measuring AusMeat colour on 300 day grain-fed cattle.