RATE OF BLOOM OF BEEF LONGISSIMUS LUMBORUM: EFFECTS OF MUSCLE TEMPERATURE, AGE, AND OXYGEN EXPOSURE TIME

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Summary

Steaks from 12 loins were used to determine the best time and temperature combinations for blooming (development of a bright-red color) of the longissimus muscle at 2, 14, and 26 days postmortem. The lowest temperature (28°F) provided the fastest rate of bloom when the muscle was 2 days postmortem, and 30 minutes were needed to achieve 75% of final bloom color. For meat 14 days old, greater bloom occurred at 35 and 40°F than at 28°F. For meat 26 days old, rate of bloom was equal at all three temperatures. Thus, packers should bloom carcasses one-half hour at 28°F before presenting carcasses for grading, and retailers will need 30 to 40 minutes after cutting to achieve 75% of final bloom at 35° to 40°F.

Introduction

In packing plants, USDA graders assign quality grades to carcasses after the ribeye has been exposed to air. A fully bloomed or bright, cherry-red ribeye provides the best color for the grader, making it easier for the grader to see the carcass marbling and maturity. In packing plants, the time between carcass ribbing and when the grader views the ribeye is "bloom time." The amount of time the ribeye is exposed to air ultimately affects the carcass grade, but this varies from facility to facility because of plant design, product line speed, and number of cattle slaughtered per day. In addition, the temperature of the ribeye muscle during blooming may affect the rate of bright red color development. Other factors influencing the grade a carcass receives include lighting type and intensity at the grader's stand, occurrence and prevalence of "heat ring" or dark coarse area in the ribeye, and whether the carcasses were electrically stimulated.

When exposed to oxygen, freshly cut muscle myoglobin (deoxymyoglobin) converts to oxymyoglobin, which has a bright, cherry-red color. However, at higher muscle temperatures, enzymes naturally present in the muscle will be more active and will consume much of the available oxygen. Because the enzymes will compete with myoglobin for oxygen, the myoglobin takes longer to convert to oxymyoglobin. Therefore, at colder temperatures, meat should bloom faster because the competing enzyme activities are depressed and consume less oxygen.

In addition to time and temperature conditions, aging of meat can influence bloom rate. Previous research showed that: 1) Aged meat bloomed better, because enzymes were less active and the oxygen penetrated faster and deeper into the muscle, thus intensifying the oxymyoglobin color, and 2) Blooming occurs faster at lower temperatures, which further slows enzyme activity and increases the penetrability of oxygen into the meat surface. The rate of bloom following aging is important in retail situations, where the primal cuts are removed from vacuum packages and sliced into retail cuts for display. However, the superior bloom of aged meats is short term, as the color stability during display of aged meats is shorter than desirable.

The objective of this study was to evaluate the combined effects of bloom time, age, and meat temperature (28, 35, and 40°F) on the rate of bloom of beef loin (longissimus lumborum) at 2, 14, and 26 days postmortem.

Experimental Procedures

Beef short loins (n=18) were delivered at approximately 24 hours postmortem by Excel Corporation to the Kansas State University Meats Laboratory. Twelve loins were selected based on their pH and incoming temperature (Table 1). Each loin was divided into three portions (approximately 4 inches long). Each loin section was then assigned to one of three temperature treatments (28, 35, or 40°F), vacuum packaged, and stored overnight at that temperature for tempering and equilibration. At 2 days postmortem, loin sections were removed from the vacuum package and a 1-inch thick steak was cut to obtain a fresh-cut surface. The marbling (Table 1) was recorded for each loin using a fresh cut surface of the steak removed on day 2 from the most anterior section of the loin. The unused section of loin from each temperature treatment was then vacuum packaged again for storage at 35°F for 14 and 26 days.

The fresh-cut surface was scanned immediately (time 0) and at 5, 10, 15, 20, 30, 40, 50, and 60 minutes using a Miniscan™ XE Plus (Hunterlab, Reston, Virginia). Three scans were taken at each time for spectral data from 400 to 700 nm using a 3-cm aperture. Percentage oxymyoglobin was calculated for each blooming time from the spectral data. For each sampling day, the Miniscan was calibrated, according to the manufacturer's guidelines, prior to the start of measuring meat color and then was recalibrated halfway into the experiment.

After 13 and 25 days of storage, the sections were placed into their treatment temperature to temper approximately 15 hours prior to subsequent blooming at 14 and 26 days. The loin sections were placed in three separate open top coolers maintained at the assigned temperatures.

Data were analyzed using the SAS System for Windows, with $\alpha=0.10$. The design of the experiment was a split-plot with repeated measures. Temperature was used as a covariate to predict the rate of bloom at 28, 35, and 40°F.

Results and Discussion

Percentage oxymyoglobin is a good indicator of bloom rate, where the higher the percent oxymyoglobin, the better the bloom for the steaks. When all three temperatures are graphed for each time period (Figure 1), the effect of temperature becomes evident. At 2 days, the lowest temperature (28°F) had the fastest and 40°F had the slowest bloom rate. However, after 14 days of vacuum aging, blooming rate at the lowest temperature was the slowest and the highest temperature (40°F) had the fastest rate. As meat aged to 26 days, blooming rates were equal at all three temperatures.

Data in Figure 2 show effects of postmortem age on rate of bloom at three temperatures. At 28°F the 2-day-old steaks bloomed faster than steaks aged 14 or 26 days, which agrees with previous research. At the coldest temperature, enzymes were less active, allowing the muscle to utilize more of the oxygen to convert deoxymyoglobin to oxymyoglobin faster than at higher temperatures. However, very little difference was found between the three time periods at 35°F for rate of bloom of the steaks. At 40°F, 2-day-old steaks had the slowest rate of bloom, presumably because the enzymes are warm enough to compete with the myoglobin for oxygen and the greatest enzyme activity would be expected in 2-day-old muscle. Therefore, the higher temperatures slow bloom at 2 days. For 14-day-old muscle, 40°F yielded the fastest rate of bloom, because aging the meat caused decreased enzyme activity. This allowed more of the oxygen to go straight to the muscle allowing it to bloom faster at 14 days and at 40°F.

To achieve the highest possible USDA quality grade and minimize the number of carcasses that need to be re-graded, a bright, cherry-red, bloomed color of the ribeye is essential. Our data show that a minimum of 20 minutes is needed to assure adequate bloom between beef carcass ribbing and when the grader evaluates the carcass. In addition, the colder the ribeye, the faster the bloom rate will be for 2-day-old carcasses. After 20 minutes at 28°F, approximately 65% of the pigment on the meat surface was converted to oxymyoglobin, and by 30 minutes about 75% was oxymyoglobin. We believe that 65 to 75% oxymyoglobin facilitates accurate grading and that these levels can be achieved fastest at meat temperatures of 28°F. Thus, for plants with good chill systems, the bloom time may be as short as 20 minutes. When ribeye temperatures are 35°F or above, longer bloom times will be needed. For retailers who deal with aged meat, 35 to 40°F appears adequate for blooming; however, colder temperatures will improve color stability compared with the warmer temperatures.

Table 1: pH, Marbling Score, and Quality Grade for Beef Strip Loins

Loin number	pH	Marbling score	Quality grade
1	5.5	Slight 70	Select
2	5.5	Slight 0	Select
3	5.5	Slight 40	Select
4	5.5	Small 60	Low Choice
5	5.5	Slight 80	Select
6	5.5	Traces 80	Standard
7	5.5	Small 70	Low Choice
8	5.6	Slight 80	Select
9	5.5	Modest 10	Average Choice
10	5.5	Small 40	Low Choice
11	5.6	Small 30	Low Choice
12	5.5	Slight 50	Select

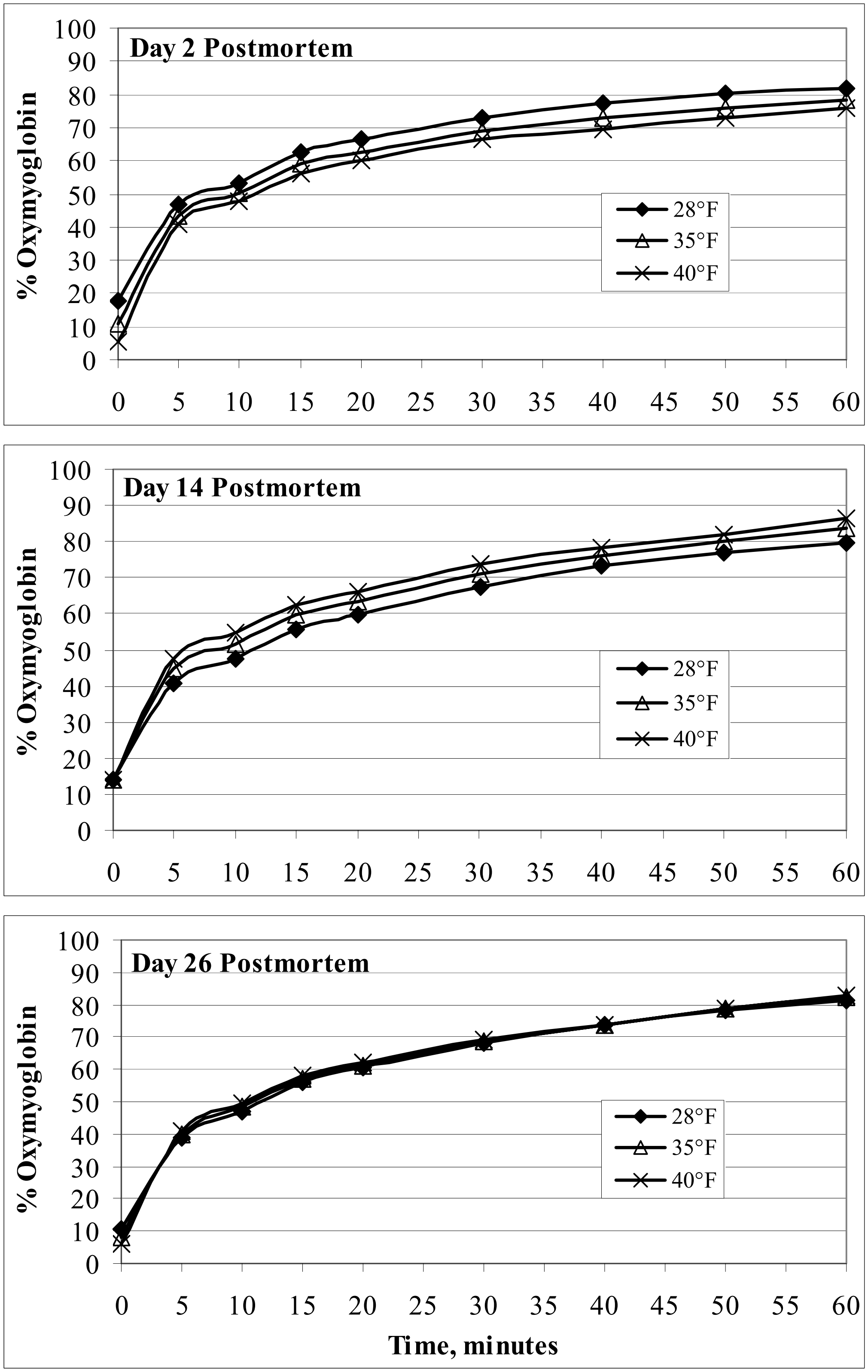

Figure 1. Estimated Percentage Oxymyoglobin in Longissimus Lumborum Held at 28, 35, or 40°F on Days 2, 14, and 26 Postmortem.

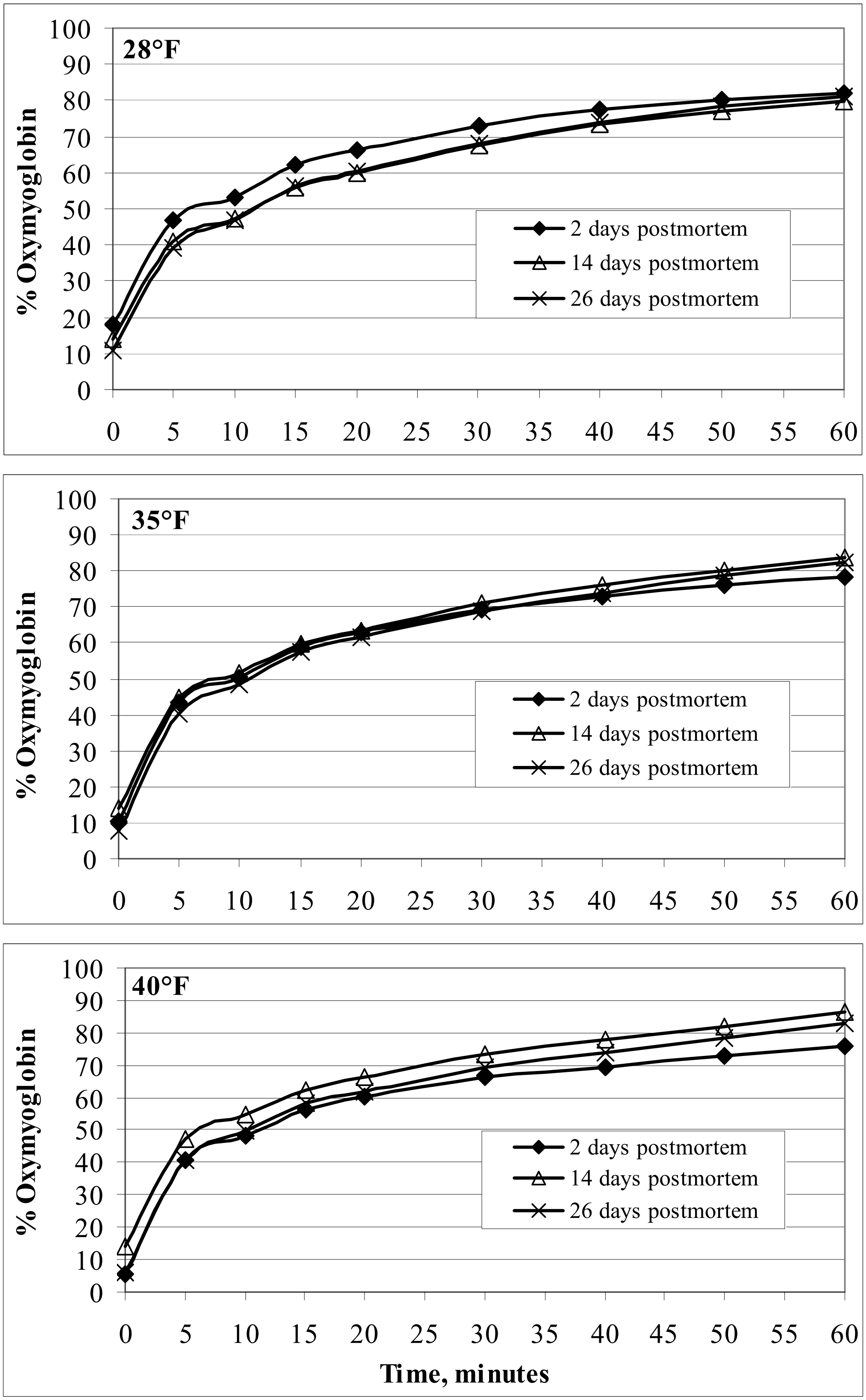

Figure 2. Estimated Percentage Oxymyoglobin in Longissimus Lumborum on Days 2, 14, and 26 Postmortem Held at 28, 35, or 40°F.