



pH Variability and its Relationship with Sarcomere Length and Free Calcium in Beef from Commercial Cattle in Puerto Rico

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Objectives

Research conducted at the University of Puerto Rico noted that beef with elevated pH values (> 5.86) resulted in more tender meat ($P \leq 0.05$). It has been established that proteolytic degradation mechanisms can be influenced by pH and calcium concentration in muscle. Beef with pH values ≥ 5.86 is classified as Dark Firm and Dry (DFD) but there are negative implications associated with greater pH values. However, observations indicating increased tenderness with increased pH raise the question: can variations in pH be associated with differences in sarcomere length (SL) and free calcium concentration (FCC)? Therefore, the objectives of this project were to: (1) document pH distribution; (2) determine the incidence of DFD; and (3) evaluate the relationship between pH, SL, and FCC in commercial cattle harvested in Puerto Rico.

Materials and Methods

Longissimus lumborum samples ($n = 51$) were obtained and background information was noted including number of permanent incisors (PI), type (Dairy or Beef), and gender. The pH values were used to categorize beef into the following groups: Low (≤ 5.40), Normal (5.41 to 5.59), High (5.60 to 5.85) and DFD (≥ 5.86). Meat was flash frozen, powdered, and placed on a microscope slide and a Helium-Neon laser was used to determine SL. A subset of samples was sent off and prepared at the University of Nebraska-Lincoln for FCC quantification (Ward Laboratories; Kearney, NE) with an inductively coupled plasma emission spectrometer (iCAP 6500 Radial; Thermo Electron, Cambridge, UK). All statistical analyses were conducted in SAS (9.4). The Proc FREQ was used to determine pH category distributions and incidence of DFD. The Proc GLIMMIX and Tukey

adjustment ($\alpha = 0.05$) were used to determine the effects of number of PI, type, and gender on pH category, SL and FCC. The Proc CORR was used to evaluate the relationship between pH category, SL and FCC.

Results

The pH category distribution for the current samples was as follows: 3.92% Low, 41.18% Normal, 35.29% High and 19.61% DFD. The SL ranged from 1.69 to 1.46 mm with an average of 1.53 mm. The FCC ranged from 132.19 to 31.39 mM with an average of 64.23 mM. Longer sarcomeres were detected in cattle with eight and zero PI (1.57 and 1.56 mm, respectively); cattle with two and four PI had intermediate SL (1.53 and 1.52 mm, respectively), and cattle with six PI had the shortest sarcomeres (1.51 mm; $P = 0.03$). Dairy cattle had longer sarcomeres relative to beef cattle (1.56 vs. 1.52 mm; $P = 0.02$). Dairy cattle tended to have increased FCC relative to beef cattle (70.72 vs. 58.38 mM; $P = 0.08$). Also, FCC tended to be greater within the Normal and Low pH categories relative to the High and DFD categories (72.36 vs. 57.31 mM; $P = 0.06$). The SL and FCC had no relationship ($P > 0.05$) within the Low, Normal and High pH categories. However, DFD beef had longer SL (0.78; $P = 0.01$), while having decreased FCC (-0.66 ; $P = 0.04$).

Conclusion

Over half (54.90%) of the beef samples analyzed fell into the High and DFD pH categories, with nearly 20% being classified as DFD. Although, a clear relationship was not established between SL and FCC within the Low, Normal or High pH categories, the results indicate that the increased pH in samples surpassing the DFD threshold correspond to longer sarcomeres and decreased free calcium.