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Meat and Muscle Biology™

The Influence of Mitochondria Enzyme Activity on Beef Tenderness

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Objectives

Among all eating quality attributes, tenderness is often described as the most important factor dictating the overall acceptance of cooked beef, as well as, future decision to repeat purchase. While many intrinsic and extrinsic factors impact end-product tenderness, variation in tenderness is usually attributed to the extent of postmortem proteolysis occurring during meat aging. Evidence from the literature indicates that muscle fiber type composition is a major source of variation in the rate and extent of postmortem proteolysis. One of the major differences that distinguishes muscle fibers is the content of mitochondria. Typically, red muscle (slow-oxidative) is characterized by greater amounts of mitochondria than white muscle (fast-glycolytic). As part of the calcium buffering system, mitochondria sequester large quantities of calcium to maintain a constant cytosolic calcium level. We hypothesized that mitochondria may delay the activation of μ-calpain, the major protease responsible for postmortem proteolysis, through preventing the increase in cytosolic calcium concentration.

Materials and Methods

To test our hypothesis, beef *longissimus thoracis* muscle samples were collected at 30 min and 16 d postmortem. The 30 min samples were immediately snap frozen in liquid nitrogen and stored at – 80°C, while the 16 d samples were used to determine Warner-Bratzler shear force (WBSF) values. Based on WBSF values, the samples were allocated into less tender (average WBSF = 5.3 kg; n = 8) or more tender (average WBSF = 2.3 kg; n = 8) categories. Succinate dehydrogenase (SDH) abundance, citrate synthase (CS) activity, phosphofructokinase (PFK) activity, and glycogen phosphorylase (GP) activity were compared between the two categories using the 30 min samples. Collected data were analyzed using a Student's t test and considered significant at $P \leq 0.05$.

Results

Our results showed that SDH abundance and CS activity (mitochondrial biomarkers) were significantly greater (P = 0.01 and 0.003, respectively) in less tender samples when compared to more tender samples. On the other hand, PFK and GP activities (glycolytic biomarkers) were greater ($P < 0.05$) in the more tender than less tender steaks.

Conclusion

While not a cause and effect relationship, these data indicate that mitochondria content likely plays a role in development of beef tenderness.