Published February 1, 2019

2017 Reciprocal Meat Conference – Muscle and Lipid Biology and Biochemistry

Meat and Muscle Biology™

Excess Glycogen Does Not Resolve High Ultimate pH of Beef, Lamb, and Chicken Oxidative Muscle

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Keywords: beef, chicken, glycogen, pork, ultimate pH
Meat and Muscle Biology 1(3):154 **doi:10.221751/rmc2017.147**

Objectives

Glycogen is the main energy source during the conversion of muscle to meat. Lower glycogen levels of oxidative muscle antemortem were thought to contribute to a higher ultimate pH. However, excess glycogen did not resolve the high ultimate pH of porcine *masseter* (oxidative) muscle. To understand this phenomenon further in other species, we hypothesized that excess glycogen may not resolve the high ultimate pH of oxidative muscles in beef, lamb, and chicken.

Materials and Methods

Six market-weight beef cattle, lambs, and chickens were harvested at The Ohio State Meat Center under USDA-FSIS supervision. *Cutaneous trunci* (glycolytic) and *masseter* (oxidative) muscle samples from the ruminants, and *pectoralis major* (glycolytic) and *sartorius* (oxidative) muscle samples from the chickens were collected immediately after exsanguination. The samples were snap frozen in liquid nitrogen and stored at –80°C until further analysis. Muscle samples were powdered in liquid nitrogen and homogenized into an anaerobic glycolysis buffer containing 10 mM Na_2HPO_4 (pH 7.4), 5 mM MgC_{l2}, 60 mM KCl, 5 mM ATP, 0.5 mM ADP, 0.5 mM NAD^+, 30 mM glycogen, 25 mM carnosine, 30 mM creatine, and 10 mM sodium acetate at 100 mg muscle/mL. Reaction vessels were placed in a dry heating block at 25°C and aliquots were removed at 0, 30, 60, 120, 240, and 1440 min for pH, glycogen, glucose 6-phosphate, glucose, and lactate analysis. Data were analyzed with a mixed model in JMP. Individual animals were recognized as an experimental unit and time-course data were analyzed with a split-plot design. The least squares means were evaluated with a Student's *t* test and considered significant at $P \leq 0.05$.

Results

Glycogen content between muscle homogenates was similar at 0 min in all the species and decreased significantly ($P < 0.001$) with time. However, both glycolytic and oxidative muscle homogenates contained residual glycogen at 1440 min which indicated that glycogen was not completely depleted in all species tested. The muscle homogenate pH decreased ($P < 0.001$) with time in all species. However, the ultimate pH at 1440 min of the oxidative muscle homogenates was significantly ($P \leq 0.023$) greater than the glycolytic muscle homogenates in all species tested. Lactate content increased ($P < 0.001$) with time in all muscles, but the oxidative muscle homogenates contained decreased ($P \leq 0.0231$) lactate levels at 1440 min in all species tested. Glucose 6-phosphate content increased significantly ($P < 0.001$) from 0 to 30 min in both muscles of all species tested, followed by relatively consistent levels until 240 min. There was again a significant ($P \leq 0.023$) increase in glucose 6-phosphate levels from 240 to 1440 min in all the muscles, however the levels were significantly ($P \leq 0.005$) lower in oxidative muscles as compared to glycolytic muscles in all the species tested. These results are consistent with the previous findings in pigs.

Conclusion

Combined these data indicate that glycolysis and pH decline terminate prematurely in the presence of excess glycogen in postmortem oxidative muscles across livestock species.

