RESEARCHREPORT

pork checkoff

PORK QUALITY

Title: Effects of pH, Temperature and Muscle Fiber Type on Postmortem Metabolism. – **NPB# 99-107**

Investigator: David E. Gerrard

Institution: Purdue University

Date Received: 11/8/2000

I. **Abstract:** The overall goal of this project is to understand better the molecular basis of pale, soft, exudative (PSE) pork development during the critical early (<1 h) postmortem period. The specific objective of this project is to determine the role of pH, temperature and muscle fiber type on postmortem metabolism. Myofibrils from red (RST) and white (WST) semitendinosus muscle were purified and used to represent extremes in muscle fiber type (RST: red, slow contracting and WST: white, fast contracting) composition. Myofibrils were subjected to various temperature/pH combinations representing those typically present in pork carcasses soon after slaughter. Data from these studies show that myofibrils from WST hydrolyze ATP faster ($P < 0.05$) at all temperatures studied. There was, however, pH X temperature interaction ($P < 0.05$) suggesting that myofibrils possessing different fiber types respond more adversely to different pH/temperature combinations. These data support our hypothesis that pigs varying in muscle fiber type may vary in their "susceptibility" to adverse pork quality development.

II. **Introduction:** Understanding the underlying mechanism for why some pigs develop adverse pork quality in the absence of detrimental genes, like the halothane gene, must be occur before we can detect, correct or select against such genotypes. Results of this study support the role of muscle fiber type in precipitating adverse pork quality development. Now that we know that muscle fiber type can affect meat quality, we can begin to include this attribute into our selection programs. This should have a major impact on the way different genetic lines are developed and utilized in the US.

III. **Objectives:** Determine the effects of temperature and pH on myofibrillar ATPase of myofibrils extracted from fast and slow muscles.

IV. **Procedures:** Muscle samples were collected immediately postmortem (<15 min) from the red (RST, predominately red fibers) and white (WST, predominately white fibers) semitendinosus muscles. Myofibrils were purified according to established procedures. Resulting protein concentrations were determined and samples were stored in glycerol at –20 C. An aliquot of myofibrils was centrifuged and washed several times with buffer. ATPase activity was then determined for each muscle fiber type. In order to model temperature and pH, ATPase activities were monitored for both fiber types at different pH and

temperature conditions. Furthermore, red fiber types were titrated against white fiber types. This was done by diluting one myofibril preparation with the other and provided data regarding the subtle differences in muscle fiber type and ATPase activity. These experiments were replicated three times using ten pigs. All data were subjected to analysis of variance. Student's t-test was used to determine significant differences between treatment means.

V. **Results:** Figure 1 shows the effects of pH and temperature on the ATPase activity of myofibrils isolated from white (WST) and red (RST) semitendinosus muscles. Myofibrillar ATPase activity was determined at 37 and 41.5^{o}C at pHs 5.0, 5.5, 6.0, 6.5, and 7.0 in order to simulate early (<1 h) postmortem muscle conditions. This data suggests that myofibrillar ATPase activity, which is the driving force of postmortem glycolysis, is highly dependent upon pH and temperature conditions. Furthermore, muscle fiber type also dictates postmortem ATPase activity, as the WST has roughly a 2-fold higher ATPase activity than the RST. The graph indicates that the pH range 5.0-6.0 is the most critical range in which fiber type-pH interactions may alter ATPase activity. Figure 2 shows the ATPase activity of the RST and WST over the critical region from pH 5.0-6.0, with measurements taken at 0.1 pH unit intervals. This graph demonstrates that there is a pH-temperature interaction that is dependent upon muscle fiber type, as the ATPase activity of the WST and RST declined at different rates over these simulated postmortem conditions. Figure 3 illustrates that the regulation of the ATPase activity for different fiber types is dependent upon Ca^{2+} level. Further experimentation is needed to characterize the fiber type-dependent ATPase activity over postmortem Ca^{2+} levels as this attribute can aggravate ATPase activity.

VI. **Discussion:** During the transformation of muscle to meat, glycogen is metabolized to lactate. This accumulation of lactate drives muscle pH to an ultimate level around 5.6. The rate of this conversion is related to changes in pork quality. The reason for this difference in "rate of conversion" classically have been credited to changes in calcium metabolism, mainly those changes observed in pigs possessing mutations in the halothane gene. It has been our stance, however, that even in halothane negative pigs, there is an inherent susceptibility of some genotypes to develop adverse pork. We have accused muscle fiber type composition as the culprit behind this aggravated postmortem muscle metabolism. These data support our claims and show that the ability of muscle to hydrolyze ATP is incumbent on muscle fiber type composition. Therefore, some attention to muscle fiber type must occur when developing the ultimate pig genotype.

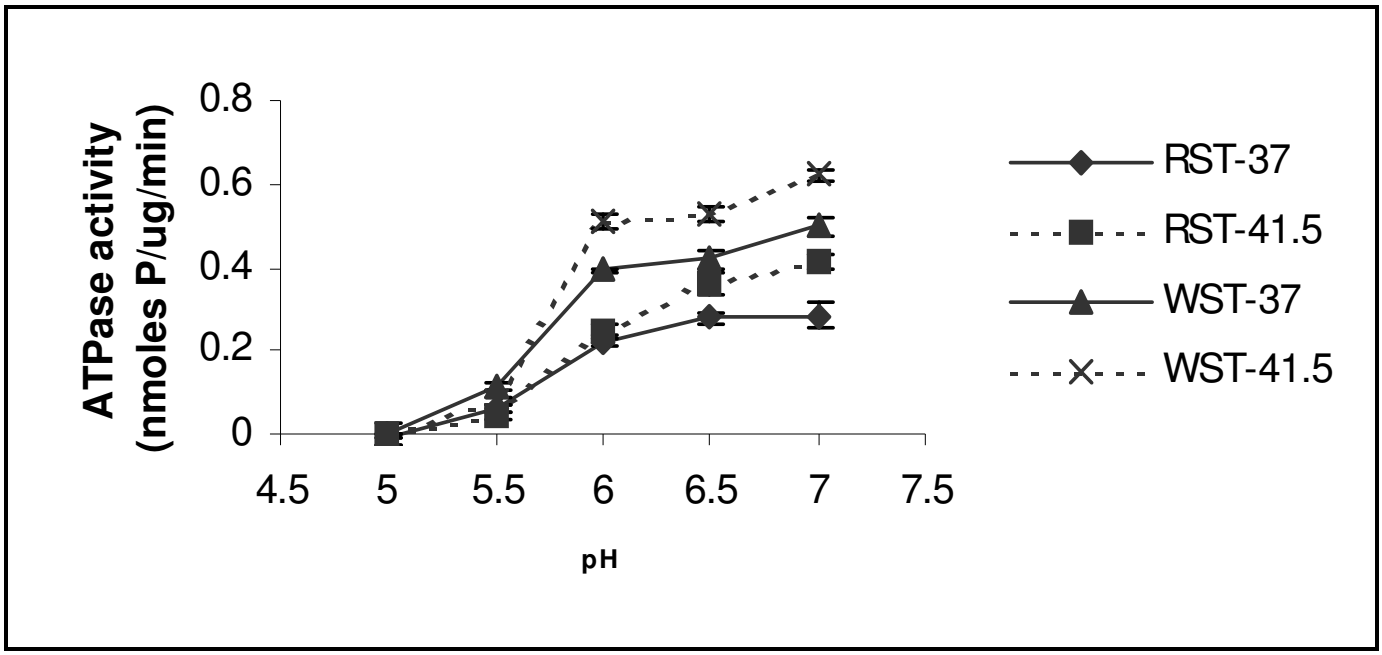

Figure 1. Effects of pH and temperature (37 and 41.5°C) on ATPase activity using myofibrils isolated from white (WST) and red (RST) semitendinosus muscles.

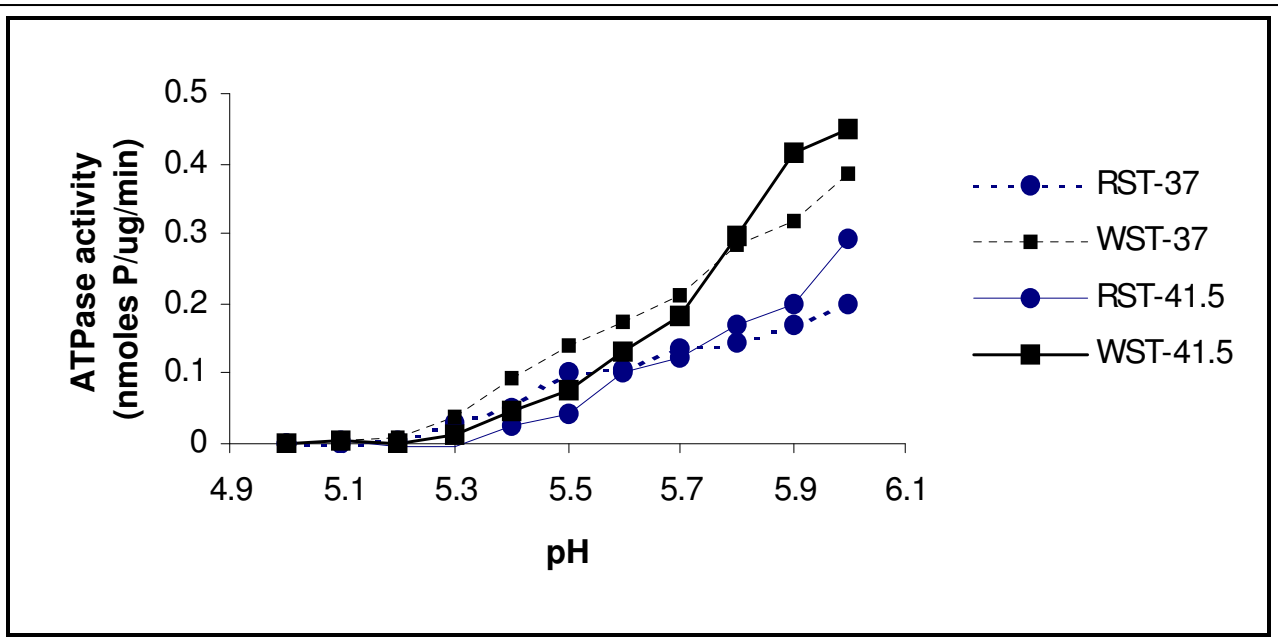

Figure 2. Effects of pH and temperature (37 and 41.5 C) on ATPase activity using myofibrils isolated from white (WST) and red (RST) semitendinosus muscles.

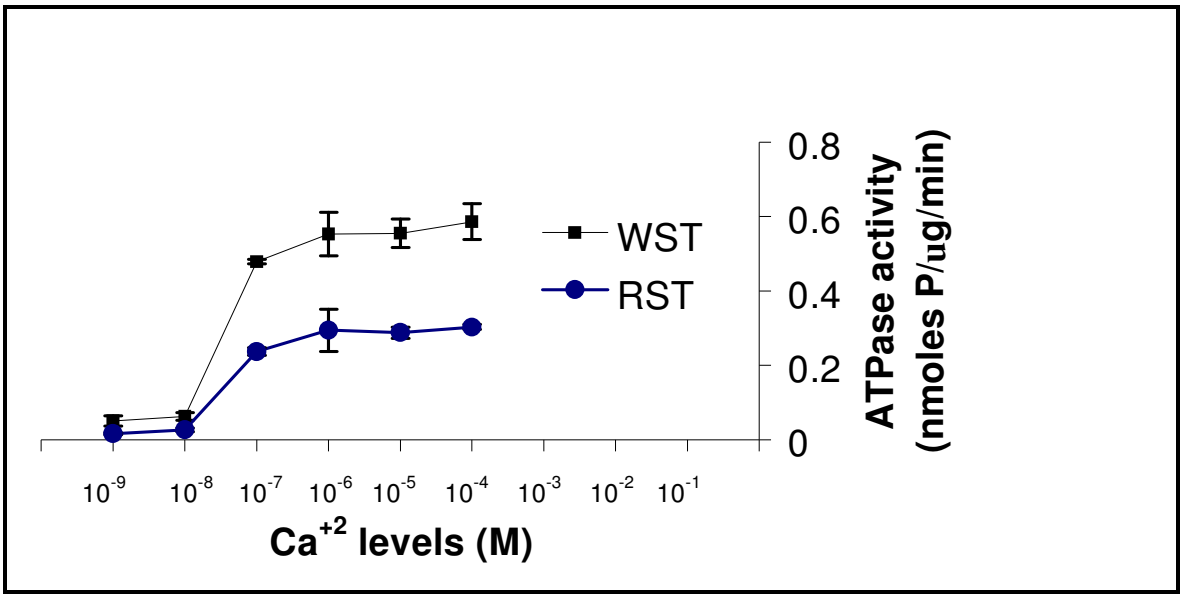

Figure 3. Effect of calcium concentration on ATPase activity using myofibrils isolated from white (WST) and red (RST) semitendinosus muscles.