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Novel Observations of Peroxiredoxin-2 Profile and Protein Oxidation in Skeletal Muscle from Pigs that Differ In Residual Feed Intake and Health Status

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Objectives

Efficiency of pork production is critical as demand for animal protein rises with increases in global populations and income. Feed efficiency and response to disease challenge are affected by stressors that increase reactive oxygen species in muscle. Reactive oxygen species are detrimental to growth, as they require the expenditure of energy for tissue repair that could be used for weight gain. Peroxiredoxin-2 (Prdx-2) is an antioxidant enzyme that converts hydrogen peroxide to water using reactive cysteines, thus mitigating oxidation. Prdx-2 can exist in multiple oxidation states (reduced, oxidized, and hyperoxidized) and quantenary structures (dimer and decamer). Prdx-2 concentration is greater in more color stable muscles and may be an indicator of tenderness. The objective of this study was to determine differences in Prdx-2 profile and protein oxidation between pigs that differed in feed efficiency and health status.

Materials and Methods

Pigs selected for differing feed efficiency based on residual feed intake (RFI) were used in a 2 × 2 factorial design for this study. At 50 ± 7 kg in body weight, high RFI (less efficient) and low RFI (more efficient) barrows were distributed between 2 rooms in the same building. One room was inoculated with a dual respiratory/enteric bacterial health challenge. At 21 d post-infection (projected peak of illness), pigs were necropsied (total = 24, $n = 6$ per group) and longissimus muscle samples were collected. Reduced and nonreduced sarcoplasmic protein samples (β-mercaptoethanol) were used for western blot analyses. Reduced samples were used to quantify total Prdx-2, while nonreduced samples were used to evaluate hyperoxidized peroxiredoxin, Prdx-2 decamer, and Prdx-2 profile in nonreducing gels (2 distinct bands analyzed). Carbonyl content and diagonal gel electrophoresis were performed on sarcoplasmic protein samples to determine protein oxidation. Statistical analysis was performed using SAS v. 9.4 (SAS Inst. Inc., Cary, NC) with fixed effects of RFI line, infection status, and RFI line × infection status interaction. Gel repetition and necropsy day were included as random effects.

Results

Infection status was significant for the Prdx-2 band comparison in nonreducing gels ($P = 0.014$) indicating potential differences in posttranslational modifications. Compared to low RFI pigs, high RFI pigs had greater total Prdx-2 ($P = 0.035$), greater Prdx-2 decamer ($P = 0.0007$), greater Prdx-2 in the second band of nonreducing gels ($P = 0.0006$), and less hyperoxidized peroxiredoxin relative to the total immunoreactive protein ($P = 0.028$). An interaction existed between RFI line and infection status for the Prdx-2 band comparison ($P = 0.02$), with high RFI challenged pigs having greater ratios, and high RFI control pigs having lesser ratios relative to low RFI pigs. Visual analysis of diagonal gels showed more proteins with intermolecular disulfide formation in low RFI muscle samples. No significant difference was seen for carbonyl content.

Conclusion

Differences exist in Prdx-2 profile based on RFI line and infection status. High and low RFI pigs may respond differently to health challenges at the molecular level based on differences in antioxidant protein response. By defining Prdx-2 in livestock muscle, we may be better able to manage animals to meet demand for meat without increasing inputs.

