

Selection for Residual Feed Intake Alters the Protein Profile of the Mitochondria in Pigs

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Summary and Implications

Understanding the biological mechanisms underlying feed efficiency is paramount to creating a more efficient pork production system. Selection for residual feed intake (RFI) is a measure of feed efficiency and can be used as a model to determine these biological mechanisms. The mitochondria are responsible for the conversion of dietary energy to cellular energy in the form of ATP. ATP is used by many biological pathways for both growth and maintenance. These data show the mitochondria protein profile is altered with genetic selection for RFI. This alteration in protein profile indicates mitochondria from more efficient low RFI pigs may be better equipped to handle physiological stress than their less efficient high RFI counterparts. Some of these differences are highlighted in heat shock proteins, and proteins responsible for ATP production. These alterations in the protein profile provide clues for determining the biological differences between pigs genetically selected from low and high RFI.

Introduction

The biological mechanisms of feed efficiency are complex and a full understanding is needed to create a more efficient pork production system. The mitochondria produce 90% of cellular energy or ATP. ATP is created via metabolic pathways that convert energy from the diet into ATP. These metabolic pathways are comprised of many proteins each with a different function. Some of these proteins may directly relate to ATP production while others may only assist in maintaining the metabolic pathways. Changes in the amount or or to the proteins themselves may impact their function. One change a protein can undergo is phosphorylation, which can change the activity of a protein thereby changing the metabolic or supporting pathway.

Pigs selected for RFI, a measure of feed efficiency, provide a model to study changes in the protein profile based on feed efficiency. In this study pigs with low RFI are 20-30% more efficient than their high RFI counterparts while maintaining similar growth rates and back fat thicknesses. The goal of this project was to establish the extent to which the protein profile is altered between pigs genetically selected for RFI.

Materials and Methods

Eighteen pigs from the Iowa State RFI selection project were used (n = 9 high RFI, n = 9 low RFI). Mitochondria were isolated from liver and *longissimus dorsi* muscle using differential centrifugation.

Alterations in the protein profile were determined using two dimensional difference in gel electrophoresis. The use of two dimensional electrophoresis allows the separation of individual proteins by charge and molecular weight. Difference in gel electrophoresis allows the comparison of multiple samples within a single gel via fluorescent labeling of the proteins. Proteins determined to be different between high and low RFI lines were then identified via mass spectrometry. Fluorescent staining of gels for phosphorylated proteins and total proteins were used to determine modifications via phosphorylation.

Results and Discussion

Proteins determined to be different between the high and low RFI lines included multiple forms of heat shock protein 60 (3) and 70 (2) as well as ATP synthase beta subunit (3). Identification of multiple forms indicates a change in charge or isoelectric point, potentially indicating proteins that are phosphorylated. All spots related to the identified proteins were determined to be phosphorylated.

Heat shock protein 60 was increased 30-50% in the more efficient low RFI line. Additionally, heat shock protein 70 was increased in the more efficient low RFI line between 18-30%. Both heat shock protein 60 and 70 inhibit cellular death. By controlling or limiting cellular death, often times due to physiological stress, the amount of dietary energy used for repair or replacement of cells is decreased allowing more energy to be used for growth.

ATP synthase beta subunit is responsible for converting the used form of ATP, ADP, back into ATP. ATP synthase beta subunit was increase in the more efficient low RFI line between 23-37%. This indicates more efficient low RFI pigs may be able to produce more ATP. An increase in ATP could also contribute to increase in efficiency or growth. The phosphorylation of these identified spots also could indicate changes in activity between the high and low RFI lines.

The change in the protein profile between high and low RFI lines highlights the complex nature of understanding feed efficiency and the need to fully understand the mechanisms behind it.

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