

Evaluation of the Responsiveness of Swine Divergently Selected for Feed Efficiency to an Exogenous Adrenocorticotropin Hormone (ACTH) Challenge

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Jessica Jenkins, Graduate Research Assistant;
Nicholas Gabler, Assistant Professor; Lloyd Anderson,
Emeritus Professor; Jack Dekkers, Professor;
Anna Johnson, Associate Professor,
Department of Animal Science, Iowa State University;
Frank Dunshea, Professor,
Agriculture and Food Systems, The University of
Melbourne

Summary and Implications

The relationship between stress and feed efficiency in finisher swine was investigated through an adrenocorticotropin hormone (ACTH) challenge. The objective of this study was to evaluate the role of the ACTH-cortisol axis and the stress response in feed efficiency using pigs divergently selected for RFI. Gilts divergently selected for residual feed intake (RFI) were used as a model for feed efficiency and were challenged with 0.2 IU/kg BW of exogenous porcine ACTH. Serial blood samples were collected and plasma cortisol concentrations were determined. These results indicate that high-RFI pigs (lower feed efficiency) are more responsive to an ACTH challenge, but cope equally as well as pigs selected for low-RFI (higher feed efficiency).

Introduction

Improving feed efficiency is essential for increasing sustainable food production and profitability for producers. RFI is a way to genetically select pigs divergent in feed efficiency while maintaining given growth rate and composition. Residual feed intake in our model is defined as the difference between observed and expected feed intake (FI) based on average requirements for growth and maintenance, while accounting for average daily gain (ADG) and backfat (BF). Therefore, low-RFI pigs consume less feed for equal weight gain compared to their less efficient, high-RFI counterparts.

Factors that are known to contribute to divergence in feed efficiency and RFI include digestion, metabolism, and thermoregulation. Additionally, feed efficiency in cattle and sheep has also been shown to be influenced by an animal's physiological stress response. When an animal perceives an external stressor the hypothalamus secretes corticotrophin-releasing hormone (CRH). Corticotrophin-releasing hormone stimulates the secretion of ACTH from the anterior pituitary gland. This ACTH then stimulates the secretion of cortisol from the adrenal cortex. Therefore, ACTH can be

exogenously administered to induce a stress response. The responsiveness to a stressor can be measured through cortisol. Cortisol is important for reacting to a stressor, as it prepares the body for fight or flight by increasing blood sugar through gluconeogenesis, redistributing it to the brain and major muscles. Cortisol also suppresses the immune system and inhibits CRH and ACTH secretion.

The objective of this study was to evaluate the role of the ACTH-cortisol axis and the stress response in feed efficiency using pigs divergently selected for RFI.

Materials and Methods

Experimental design: The protocol for this experiment was approved by the Iowa State University Institutional Animal Care and Use Committee. The experiment was conducted from November to December, 2011. A total of 12 Yorkshire gilts (68 ± 5.2 kg) were challenged to compare high-RFI ($n=6$) and low-RFI ($n=6$).

Animals and housing: Gilts were housed in individual metabolism pens within sight and/or nose to nose contact of each other. They had been acclimated to this setting for one week prior to the study. All pigs had free access to water and were fed ad libitum and typical corn-soybean diet that met or exceeded NRC requirements for this size pig.

ACTH Challenge: After acclimation, gilts were fitted with a non-surgical catheter (Mila International Inc., Erlanger, KY, USA) in the jugular vein. Three days later the gilts were fasted overnight and challenged I.M. with 0.2 IU/kg BW of exogenous porcine ACTH (Sigma-Aldrich, St. Louis, MO, USA). Serial blood samples were collected at -30, -15, -1, 30, 45, 60, and 90 min relative to the ACTH administration. Blood was collected into tubes containing EDTA and then centrifuged at $2,000 \times g$ for 10 min at 4°C . Plasma was separated and stored at -80°C until assayed for cortisol. Plasma cortisol concentrations were determined using a DPC Immulite assay. Cortisol concentration and area under the curve data was analyzed using the mixed procedure of SAS.

Results and Discussion

Both lines of pigs responded to the ACTH challenge (Figure 1). Interestingly, the average baseline endogenous cortisol concentration (-30 to -1 min prior to ACTH administration) tended to be reduced by 25% in the low-RFI gilts, compared to the high line ($P=0.08$, Figure 2). Furthermore, the high-RFI gilts tended to have a greater area under the curve (AUC) from baseline to 90 min than

low-RFI ($P=0.07$). Throughout the challenge low-RFI cortisol concentrations peaked earlier than high-RFI (Figure 1). The high-RFI gilts tended to have a higher max concentration than low-RFI gilts ($P=0.07$). The high-RFI pigs had higher cortisol concentrations ($P=0.05$) than low-RFI pigs at 60 min.

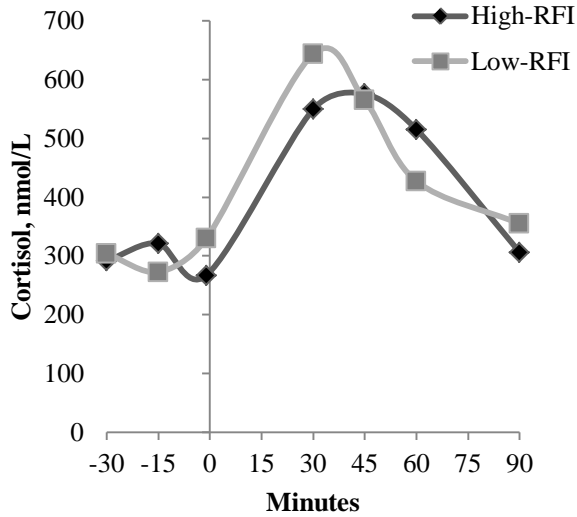


Figure 1. Cortisol concentrations over entire challenge.

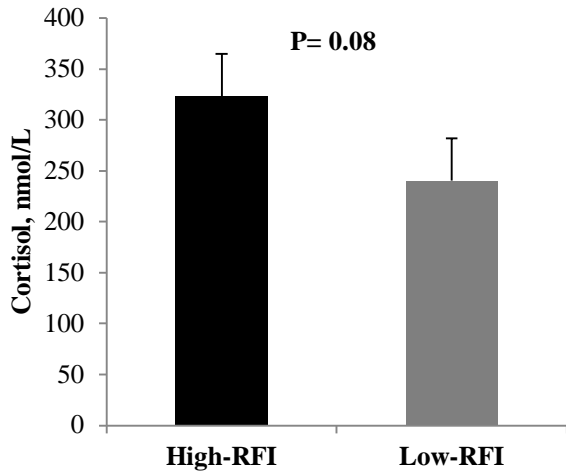


Figure 2. Average baseline cortisol concentrations.

Overall, the average post-challenge cortisol concentration was determined by averaging the four time points after ACTH administration (30, 45, 60, and 90 min). Interestingly, the average post-challenge concentrations were different between genetic line ($P=0.03$), with high-RFI pigs having a higher response than more efficient pigs (Figure 3).

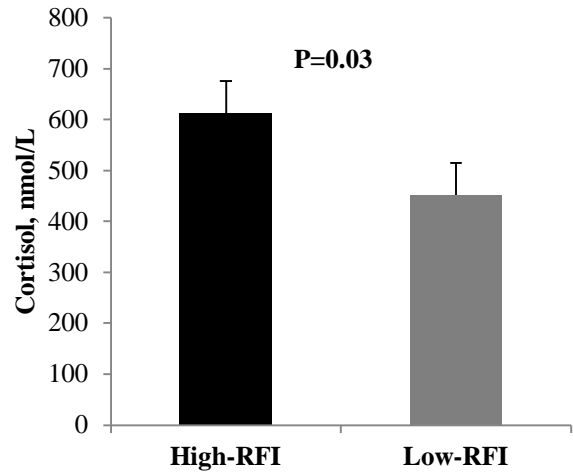


Figure 3. Average post-challenge cortisol concentrations

In conclusion, divergent selection for RFI resulted in altered pre- and post ACTH induced cortisol responses in finisher gilts. The high-RFI pigs tended to be more responsive to this stress challenge, but recovered equally as well as pigs selected for low-RFI.

Acknowledgements

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