

3-7-2016

How has selection for residual feed intake (RFI) affected the grow-finish pig's ability to cope with stress?

Samaneh Azarpajouh
Iowa State University, samaneh@iastate.edu

Jessica Colpoys
Iowa State University

Jack Dekkers
Iowa State University, jdekke@iastate.edu

Nicholas Gabler
Iowa State University, ngabler@iastate.edu

John F. Patience
Iowa State University, jfp@iastate.edu

See next page for additional authors

Follow this and additional works at: https://lib.dr.iastate.edu/ans_whitepapers



Part of the [Agricultural Economics Commons](#), [Animal Sciences Commons](#), and the [Genetics Commons](#)

Recommended Citation

Azarpajouh, Samaneh; Colpoys, Jessica; Dekkers, Jack; Gabler, Nicholas; Patience, John F.; and Johnson, Anna K., "How has selection for residual feed intake (RFI) affected the grow-finish pig's ability to cope with stress?" (2016). *Animal Science White Papers, Technical Reports, & Fact Sheets*. 8.

https://lib.dr.iastate.edu/ans_whitepapers/8

This Report is brought to you for free and open access by the Animal Science at Iowa State University Digital Repository. It has been accepted for inclusion in Animal Science White Papers, Technical Reports, & Fact Sheets by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.

How has selection for residual feed intake (RFI) affected the grow-finish pig's ability to cope with stress?

Abstract

Feed is the largest cost in pork production; therefore, improving feed efficiency can increase producer profitability. Furthermore improved feed efficiency can support industry competitiveness, decrease the demand on global feed resources, and complement environmental sustainability. Genetically, selective breeding for residual feed intake (RFI) shows promise in meeting these increased demands. However, it is important to balance the benefits of feed efficiency selection with the pig's ability to cope with stress and its welfare. Therefore, this factsheet will discuss physiological and behavioral stress research on swine selected on the basis of RFI.

Disciplines

Agricultural Economics | Agriculture | Animal Sciences | Genetics

Comments

This report is published as Samaneh Azarpajouh, Jessica Colpoys, Jack Dekkers, Nicholas Gabler, John F. Patience, Anna K. Johnson. 2016. How has selection for residual feed intake (RFI) affected the grow-finish pig's ability to cope with stress? Pork Information Gateway. Factsheet PIG 05-03-03, U.S. Pork Center of Excellence. Posted with permission.

Authors

Samaneh Azarpajouh, Jessica Colpoys, Jack Dekkers, Nicholas Gabler, John F. Patience, and Anna K. Johnson

How has selection for residual feed intake (RFI) affected the grow-finish pig's ability to cope with stress?

Introduction

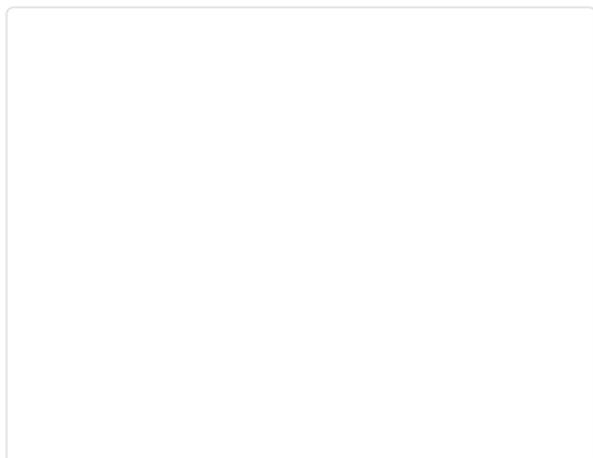
Feed is the largest cost in pork production; therefore, improving feed efficiency can increase producer profitability. Furthermore improved feed efficiency can support industry competitiveness, decrease the demand on global feed resources, and complement environmental sustainability. Genetically, selective breeding for residual feed intake (RFI) shows promise in meeting these increased demands. However, it is important to balance the benefits of feed efficiency selection with the pig's ability to cope with stress and its welfare. Therefore, this factsheet will discuss physiological and behavioral stress research on swine selected on the basis of RFI.

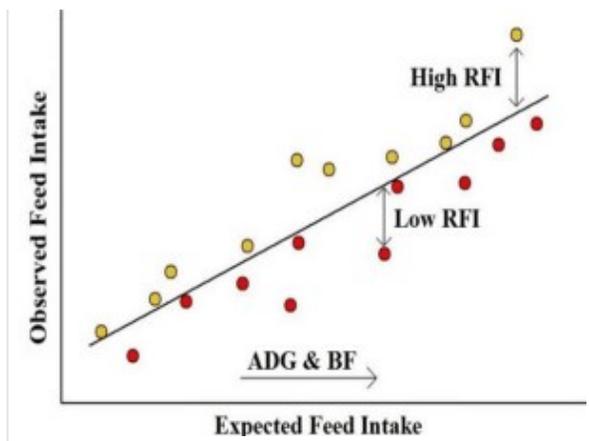
Objectives

- To explain residual feed intake and its importance.
- To discuss how residual feed intake selection impacts the grow-finish pig's ability to cope with physiological and behavioral stress.

What is residual feed intake?

Residual feed intake is one method of measuring feed efficiency. Residual feed intake is defined as the difference between a pig's observed and expected feed intake. Expected feed intake is determined for each pig, based on its growth rate and backfat thickness. Pigs that consume less feed than expected have a lower RFI, are more feed efficient, and they are therefore economically better for lean production compared to pigs with high RFI [1, 2; Figure 1]. Factors that contribute to variation in RFI are the same as those that affect feed efficiency, energy used during activity, efficiency of digestion, metabolic balance, thermoregulation [3] and temperament [4]. Using RFI, two pig lines have been developed at Iowa State University; an efficient line that has been selected for low RFI (LRFI line) over 10 generations and an inefficient line that was randomly selected for the first five generations and then selected for high RFI (HRFI line) for another 5 generations. Now in their 10th generation, pigs from the low RFI line require 12-15% less feed to reach market weight than pigs from the high RFI line.





(<https://i1.wp.com/porkgateway.org/wp-content/uploads/2016/03/Figure-1.jpg>)

Figure 1. Schematic of residual feed intake as the difference between observed and expected feed intake based on the pig's average daily gain (ADG) and backfat (BF). Pigs that are above the line have high RFI and are less efficient. Pigs that are below the line have low RFI and are more efficient.

Physiological stress response of pigs selected for RFI

Grubbs and colleagues (2013) investigated the protein profile of mitochondria from liver, semitendinosus (red portion), semitendinosus (white portion) and longissimus dorsi to determine differences between pigs from the HRFI and LRFI lines [5]. More feed efficient (LRFI) pigs indicated an increase in anti-oxidant defenses and potential modifications of metabolic pathways leading to oxidative stress, metabolism, and cellular repair. Results indicated that pigs divergently selected for LRFI may be less prone to muscular oxidative stress, and the liver may have a greater metabolic capacity when compared to their less feed efficient (HRFI) contemporaries.

- Take home message: Metabolic inefficiencies at the mitochondria may translate to increased tissue stress that antagonizes lean tissue accretion.

Colpoys (2015) investigated how selecting for RFI may impact the pig's ability to cope with stress: 1) more feed efficient pigs have lower baseline stress, or 2) more feed efficient pigs have lower response to a stress challenge [6]. Naturally, following a stressful event, pigs secrete adrenocorticotrophic hormone (ACTH) from the anterior pituitary gland, which then stimulates the secretion of cortisol from the adrenal cortex. Therefore, ACTH can be exogenously administered to induce a stress response, and the pig's responsiveness can be measured through cortisol. Cortisol is important for reacting to a stressor, as it prepares the body for a fight or flight response and therefore influences animal welfare. Colpoys (2015) evaluated the physiological stress response of gilts from the two RFI lines by administering ACTH and measuring the stress response through cortisol concentrations [6]. The results showed that LRFI (more efficient) gilts tended to have lower baseline cortisol and had lower cortisol concentrations in response to the ACTH stimulation compared to HRFI gilts.

- Take home message: Pigs selected for improved feed efficiency were better able to cope with a physiological stressor.

Therefore, we predict that in a production environment, these pigs would be more robust when exposed to

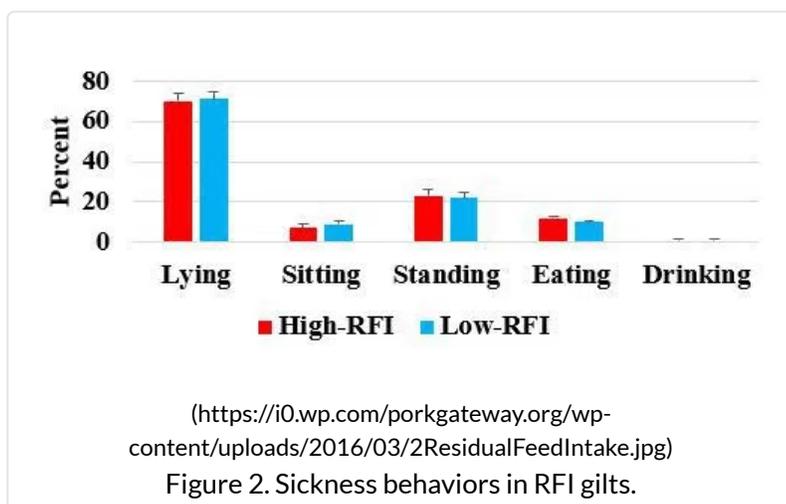
physiological stressors.

Immunological stress response of pigs selected for RFI

Dunkelberger and colleagues (2015) assessed the effect of infection with porcine reproductive and respiratory syndrome virus (PRRSV) on pigs from the two RFI lines [7]. One hundred weaner piglets from each line were infected and followed for 42 days. There was a tendency for pigs from the LRFI line to have lower levels of viremia in blood, to have a faster antibody response, and the growth rate of the LRFI pigs was less affected by infection than pigs from the HRFI line. Growth of the LRFI line was less affected by PRRSV-challenge than growth of the HRFI line. Additionally, the increase in antibody levels was greater for the LRFI line than for the HRFI line.

The lipopolysaccharide challenge can also be used to determine whether selection for improved feed efficiency impacts sickness behavior expression. A study by Azarpajouh and colleagues (2015) using gilts from the RFI lines did not show differences in sickness behaviors in response to a lipopolysaccharide challenge [8; Figure 2].

- Take home message: Genetic selection for improved feed efficiency did not affect the sickness behaviors expressed by gilts in response to a lipopolysaccharide challenge.



Rakhshandeh and colleagues (2012) evaluated the impact of lipopolysaccharide challenge and divergent selection for RFI on apparent ileal digestibility and apparent fecal digestibility of nutrients and intestinal nutrient active transport and barrier function [9]. The immune system stimulation decreased apparent ileal digestibility of nutrients. The reduction in apparent fecal digestibility of crude protein as result of immune system stimulation was greater in the LRFI line compared to the HRFI line. Genetic selection for LRFI increased the apparent fecal digestibility but had no effect on apparent ileal digestibility of nutrients. It also reduced the total tract digestive capacity of growing pigs during immune system stimulation. The immune system stimulation affected both apparent ileal digestibility and apparent fecal digestibility of dietary crude protein.

- Take home message: Pigs selected for increased efficiency based on RFI were less affected by PRRSV infection and inflammatory challenge and responded better to the disease.

Behavioral stress response of pigs selected for RFI

Sadler and colleagues (2011) evaluated the extent to which RFI selection impacted behavior and lesion presence using the RFI selection lines [10]. On the day of placement there were no postural, behavior, or general activity differences between the two lines, but over subsequent rounds, behavioral differences were observed, with LRFI gilts becoming less active. Gilts from the LRFI line also had lower lesion scores on the day after placement. However, over subsequent rounds there were no differences in lesion scores between the two lines.

- Take home message: Genetic selection for improved feed efficiency resulted in a better lesion score in gilts on the day of placement, which may be a useful tool to use in a selection program.

Novel object- and human-approach tests are commonly used to test a pig's behavioral response to fear eliciting stimuli as pigs are innately neophobic. Research conducted by Colpoys and colleagues (2014) compared behavioral reactions of barrows from the two RFI selection lines [11]. Barrows were evaluated using a human-approach (HAT) and novel object-approach test (NOT). During both HAT and NOT, LRFI barrows expressed fewer fear behaviors than HRFI barrows.

- Take home message: Genetic selection for improved feed efficiency resulted in fewer fear behaviors in barrows. Therefore we predict that when producers walk grow-finish pens, more feed efficient barrows will be less likely to touch the producer but will also be less stressed with the producer in their pen.

Summary

In summary this work is very encouraging as it relates to physiological, immunological and behavioral responses in pigs that have been selected for improved feed efficiency. Further work is needed to evaluate pigs from the more feed efficient line in commercial situations to further ascertain their robustness.

Cited literature

1. Koch RM, Gregory KE, Chambers D, Swiger LA. Efficiency of feed use in beef cattle. *Journal of Animal Science*. 1963; 22(2): 486-494.
2. Young JM, Cai W, Dekkers JCM. Effect of selection for residual feed intake on feeding behavior and daily feed intake patterns in Yorkshire swine. *Journal of Animal Science*. 2011; 89: 639-647.
3. Herd RM, Oddy VH, Richardson EC. Biological basis for variation in residual feed intake in beef cattle. 1. Review of potential mechanisms. *Australian Journal of Experimental Agriculture*. 2004; 44: 423-430.
4. Sadler LJ, Johnson AK, Nettleton D, Lewis CRG, Young JM, Lonergan SM, Dekkers JCM. The effect of selection for residual feed intake on scale-activity and scale-exit scores in Yorkshire gilts. *Animal Production Science*. 2015. <http://dx.doi.org/10.1071/AN 14849>.
5. Grubbs JK, Fritchen AN, Huff-Lonergan E, Gabler NK, Lonergan SM. Selection for residual feed intake alters the mitochondria protein profile in pigs. *Journal of Proteomics*. 2013; 80: 334-345.
6. Colpoys JD. Swine feed efficiency: Implications for swine behavior, physiology and welfare. PhD Dissertation, Iowa State University. 2015.

7. Dunkelberger JR, Boddicker NJ, Serão NVL, Young JM, Rowland RRR, Dekkers JCM. Response of pigs divergently selected for residual feed intake to experimental infection with the PRRS virus. *Livestock Science*. 2015; 177: 132-141.
8. Azarpajouh S, Colpoys JD, Rakhshandeh A, Dekkers JCM, Abell CE, Gabler NK, Johnson AK. Residual feed intake selection: Effect on gilt behavior in response to a lipopolysaccharide challenge. *ADSA-ASAS Joint Annual Meeting*. 2015.
9. Rakhshandeh A, Dekkers JCM, Kerr BJ, Weber TE, English J, Gabler NK. Effect of immune system stimulation and divergent selection for residual feed intake on digestive capacity of the small intestine in growing pigs. *Journal of Animal Science*. 2012; 90:233-235.
10. Sadler LJ, Johnson AK, Lonergan SM, Nettleton D, Dekkers JCM. The effect of selection for residual feed intake on general behavioral activity and the occurrence of lesions in Yorkshire gilts. *Journal of Animal Science*. 2011; 89: 258-266.
11. Colpoys JD, Abell CE, Young JM, Keating AF, Gabler NK, Millman ST, Siegford JM, Johnson AK. Effects of genetic selection for residual feed intake on behavioral reactivity of castrated male pigs to novel stimuli tests. *Applied Animal Behavior Science*. 2014; 159:34-40.

Frequently asked questions

Q: What is stress?

Stress is referred to as the physiological adjustments necessary to maintain homeostasis in a fluctuating environment.

Q: What are the general stages of stress?

The stress response can be divided into three general stages: the recognition of a stressor, the biological defense against the stressor, and the consequences of the stress response.

Q: Is the physiological response to stress in pigs selected for feed efficiency based on RFI different from pigs not selected for RFI?

Pigs selected for improved RFI (LRFI) demonstrate similar physiological changes when undergoing stress compared to pigs not selected for RFI (HRFI). However, more feed efficient pigs have a lower baseline and post stress cortisol levels.

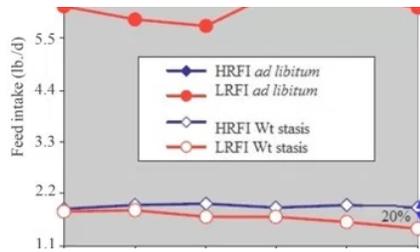
Q: Is the behavioral response to stress in more feed efficient pigs different from less feed efficient pigs?

More feed efficient pigs had lower behavioral stress responses during HAT and NOT compared to less feed efficient pigs.

Q: Where is a resource to find out more about RFI selection in pigs?

For more information check the following link <http://www.swinefeedefficiency.com/index.html> (<http://www.swinefeedefficiency.com/index.html>).

Related Resources



(<http://porkgateway.org/resource/selection-residual-feed-intake-rfi-affected-nursery-finisher-pigs-feeding-behavior-performance/>)

How has selection for residual feed intake (RFI) affected nursery and finisher pig's feeding behavior and performance?

(<http://porkgateway.org/resource/selection-residual-feed-intake-rfi-affected-nursery-finisher-pigs-feeding-behavior-performance/>)

December 21, 2017

Similar post

Practical Ideas to Address High Feed and Production Costs (<http://porkgateway.org/resource/practical-ideas-to-address-high-feed-and-production-costs/>)

Practical Ideas to Address High Feed and Production Costs

Pork producers are facing a period of rapidly increasing feed and production costs. The following management tips and resources have been compiled by the Pork

July 24, 2015

Similar post

Growing-Finishing Swine Nutrient Recommendations and Feeding Management (<http://porkgateway.org/resource/growing-finishing-swine-nutrient-recommendations-and-feeding-management/>)

Growing-Finishing Swine Nutrient Recommendations and Feeding Management

Profitability of commercial swine enterprises is affected by a variety of factors, such as the pigs genetic potential, environment, feed intake, ingredient availability and

July 24, 2015

Similar post

Resource Details

Publish Date

03/07/2016

Type

Factsheets (/resources/type/factsheets)

Category

Animal Behavior and Welfare Issues (/resources/category/animal-behavior-and-welfare-issues)

Authors

Samaneh Azarpajouh (/person/10480), Jessica Colpoys (/person/10489), Jack Dekkers (/person/10491),

Nicholas Gabler (/person/10492), John F. Patience (/person/john-f-patience), Anna K. Johnson (/person/anna-k-johnson)

Editor

Dr. Yuzhi Li (/person/dr-yuzhi-li)

Reviewer

Joel DeRouchey (/person/joel-derouchey)

Audiences

Instructors (/resources/audience/instructors), Producers (/resources/audience/producers)

Factsheets Number

PIG 05-03-03