

Juvenile IGF-I: An Early Bio-marker for Feed Efficiency in Pigs

A.S. Leaflet R3117

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Summary and Implications

At Iowa State University, purebred Yorkshire pigs have been divergently selected for increased and decreased feed efficiency based on residual feed intake for ten generations. In this study, juvenile IGF-I serum concentrations were measured in these divergently selected lines, with the goal of validating juvenile IGF-I as an early blood bio-marker to help select young piglets for later feed efficiency performance.

Previous findings (Bunter et al., 2002, 2005, 2010) and this validation study support that lower juvenile IGF-I concentration in piglets is genetically correlated with increased grow-finish feed efficiency. IGF-I concentration is a moderately heritable trait that is more cost and time effective to measure than feed intake and feed efficiency. These characteristics make IGF-I a useful bio-marker for feed efficiency in swine.

Introduction

Feed costs account for over 50% of production costs in the U.S. swine industry (Giamalva, 2014), resulting in an industry-wide objective to improve feed efficiency.

To investigate the genetic and physiological basis of feed efficiency, Iowa State University (ISU) initiated divergent selection for increased and decreased feed efficiency in parallel lines of purebred Yorkshire pigs in 2001. Residual feed intake (RFI) was utilized as the measure of feed efficiency, which is defined as the difference between observed and expected feed intake given growth and maintenance requirements (Koch, 1963).

Feed intake and feed efficiency traits, such as RFI and feed conversion ratio (FCR), are costly and time consuming to measure. So much so, that it is desirable to identify indicator traits and bio-markers to select for feed efficiency. Previous studies, including a study using data from generations two through five in the ISU RFI lines, identified juvenile insulin-like growth factor-I (IGF-I) as a potential early blood bio-marker for feed efficiency (Bunter et al., 2002, 2005, 2010). The purpose of this study was to use additional data from generation 10 of the ISU RFI lines to validate juvenile IGF-I as an early bio-marker for RFI and feed efficiency in pigs.

Materials and Methods

RFI and FCR phenotypic data were collected on grow-finish pigs (n=2,308) during ten generations (G) of divergent selection. Selection occurred for all ten generations for low RFI, or increased feed efficiency, in the low RFI line (Low RFI: n=1,531). Concurrently, a randomly mated control line was maintained for the first four generations, which was then selected for high RFI (High RFI: n=777), or reduced feed efficiency, for the remaining six generations.

Piglets (n=2,949) from generations 2, 3, 4, 5 (n=2,572) and 10 (n=377) had blood serum collected between 33 and 42 days of age. Blood samples were analyzed to determine IGF-I concentration (ng/mL) with the Primegro™ IGF assay (Rivalea, Ltd).

Multi-variate animal models were fit in ASreml 3.0 (Gilmour et al., 2009) that treated IGF-I for early (2-5) and late (10) generations as separate traits, along with RFI or FCR in early (0-7) and late (8-10) generations.

Results and Discussion

Selection for RFI resulted in correlated responses in juvenile IGF-I concentrations and FCR. In G5, IGF-I concentration was 11% lower in the Low RFI line than the High RFI line, and 27% lower in G10.

IGF-I, RFI, and FCR were estimated to be moderately heritable traits in both early and late generations. With the exception of IGF-I late from G10, which was estimated to be highly heritable, but with a large standard error (Table 1).

Phenotypic and residual correlations were estimated between early IGF-I and early RFI or FCR, but not in later generations because no animals had phenotypic data for both traits (Table 2). Estimates of genetic correlations of IGF-I with RFI and FCR were positive and moderate to high (Table 2). Estimates were higher for IGF-I with FCR than with RFI, and higher in the early generations compared to the late, but the latter had large standard errors. Results support the previously reported genetic relationship between IGF-I and feed efficiency.

In conclusion, juvenile IGF-I concentration was shown to diverge with selection for RFI. It was estimated to have a moderate to high genetic correlation with feed efficiency traits, and to be moderately heritable, making it a useful early bio-marker for RFI and other feed efficiency measures.

Acknowledgments

We gratefully acknowledge the work of the farm staff at the Lauren Christian Swine Research Center and Rivalea Ltd, Australia. This project was supported by AFRI-NIFA Grant #2011-68004-30336.

Iowa State University Animal Industry Report 2016

Table 1. Genetic parameter estimates.

Traits	Heritability	Litter Variance	Pen-cohort Variance	Phenotypic Standard Deviation
IGF-I Early, ng/mL	0.29 ± 0.06	0.17 ± 0.03	---	83.4
IGF-I Late, ng/mL	0.94 ± 0.39	0.03 ± 0.18	---	69.7
RFI Early, kg/d	0.25 ± 0.06	0.05 ± 0.03	0.38 ± 0.07	0.120
RFI Late, kg/d	0.32 ± 0.10	0.16 ± 0.06	0.28 ± 0.09	0.146
FCR Early, kg feed/kg gain	0.21 ± 0.06	0.11 ± 0.03	0.20 ± 0.04	0.250
FCR Late, kg feed/kg gain	0.35 ± 0.11	0.11 ± 0.06	0.19 ± 0.06	0.290

--- Not applicable because not fit in model for all traits

Table 2. Trait correlation estimates.

Traits	Phenotypic Correlation	Genetic Correlation	Residual Correlation
IGF-I Early to RFI Early	0.12 ± 0.04	0.59 ± 0.17	-0.06 ± 0.06
IGF-I Late to RFI Late	---	0.25 ± 0.32	***
IGF-I Early to FCR Early	0.23 ± 0.04	0.74 ± 0.16	0.25 ± 0.32
IGF-I Late to FCR Late	---	0.51 ± 0.34	***

--- Cannot estimate because there is no overlapping phenotypic data between traits

*** Residual Covariance was non-estimable