Use of IGF-1 as a selection criteria in pig breeding

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Introduction

Insulin-like Growth Factor - 1 (IGF-1) fulfils a number of criteria for potential inclusion as an indirect selection measure. It can be accurately and relatively inexpensively measured in the blood of young animals and has been shown to be significantly related to growth rate in pigs. However, there was little information on its heritability or genetic correlations with economically important traits in pigs. In other words would IGF-1 respond to selection and secondly would genetic changes in IGF-1 result in improved performance in pigs.

The following traits were measured in an initial trial; plasma concentration of IGF-1 at 5 weeks of age, average daily gain from birth to 24 weeks of age (ADG) ultrasonic fat depth at the last rib (P2), feed intake and feed conversion efficiency from 19 to 24 weeks of age (FI and FCE) and drip loss of the LD muscle (DLP). Two breeds. Large White and Landrace were used. The heritability and correlations were obtained using DFREML with an average information (AI) algorithm. The heritability of IGF-1 was 0.22 ± 0.09. The number of observations, genetic (r_g) and phenotypic (r_p) correlations for IGF-1 and the performance traits are presented in Table 1.

Table 1. Genetic and residual correlations between IGF-1 and a number of performance traits.

Trait	ADG	P2	FI	FCE	DLP
Number	3522	3575	3531	3500	2318
r_g	-0.47	0.29	0.37	0.84	-0.26
r_e	0.24	0.18	0.01	-0.08	-0.17

IGF-1 was negatively correlated with growth rate and positively correlated with P2 and feed conversion efficiency. In other words selection for lower levels of IGF-1 should result in leaner, faster growing and most importantly more efficient pigs. A selection study was carried out to validate the heritability value and genetic correlation outlined above.

The study consisted of a one generation selection measuring males and females for IGF-1 at five weeks of age and selecting boars and with the highest and lowest values for subsequent mating. The high value males were mated to the high value females and low males to low females. The subsequent progeny were then measured for IGF-1 and a number of performance traits. Any differences observes between the two groups of progeny are a result of the genetic differences of their parents in IGF-1. From the data we calculated a realised heritability and correlated selection responses for a number of performance traits.

Materials and Methods

Two hundred Large White males and two hundred Large White females were measured for IGF-1 at approximately five weeks of age. IGF-1 was assayed using a modified commercial elisa kit. At twenty five weeks of age two groups comprising six boars and thirty six gilts with the highest and lowest IGF-1 values, respectively were selected for breeding. The high value boars were mated to the high value gilts and low value boars mated to the low value gilts. The resulting progeny were then measured for the following traits:

- IGF-1 at approximately five weeks of age
- Rate of gain over the lifetime
- Rate of gain over the test period
- Feed intake over the test period
- Feed efficiency over the test period
- Fat depth over the last rib, 6.5cm off the midline
- Fat depth between the third and fourth last rib, 6.5cm off the midline
- Fat depth over the ham, 6.5cm off the midline
- Muscle depth over the last rib, 6.5cm off the midline
- Percentage fat in the carcase.
- Carcase dressing percentage
- Colour of the Longdissimus Dorsi muscle
- Colour of the Superior Spinalis muscle
- pH of the Longdissimus Dorsi muscle 24 hours after slaughter

Pigs went on test at approximately 75 kg and fed ad libitum for a six week period. Progeny which did not go on test remained under commercial conditions. The test was carried out in electronic feeders in an average group size of 35 pigs per pen. The pigs averaged 103 kg off test. All fat measures were recorded using a real time ultrasound. The colour measures are the L values from a Minolta Chronometer. A total of 388 progeny were measured for growth rate over the animals lifetime and the linear fat measures at the last rib and over the leg. Fat percentage of the carcase was estimated using an algorithm combining the fat measurements and carcase weight. A random sample of 276 animals went onto test, with 110 of them being slaughtered for the meat quality measures.

The realised heritability was calculated as the selection response, which is the difference between the high and low progeny group values for IGF-1, divided by the selection differential, which is the difference between the average of the high and low parent IGF-1 values. The estimates of the genetic correlations obtained in the initial experiment were used to estimate correlated selection responses in the performance traits in this experiment, using the normal equation for estimation of correlated responses, with the selection intensity generated in this experiment and the realised heritability for IGF-1 and heritability estimates for the performance traits obtained in recent experiments using this line. Differences between the high and low IGF-1 groups and boars and gilts were analysed with standard analysis of variance and covariance techniques. Analysis of the linear fat and muscle depth data included final live weight, and sex as covariates. The analysis of the data off test included entry weight and sex as covariates.

Results and Discussion

In Table 2 the average IGF-1 levels for the sires, dams and progeny for the two groups are presented.

Table 2. Average IGF-1 Levels for Sires, Dams and Progeny for the Two Groups.

_	High	Low
Sires	179	33
Dams	138	47
Progeny	99	65

The data from the table above corresponds to a realised heritability estimate of 0.28, which is marginally higher than the previous estimate recorded in the population studies. Average performance for growth rate over the lifetime and fat depth over the last rib and leg are presented for the two groups in Table 3.

Table 3. Average Performance Values For Both Groups.

Trait	High	Low	SEM
Lifetime Growth Rate (gms/day)	590	570	4
Fat Depth Last Rib (mm)	26	14	0.2
Fat Depth Over Leg (mm)	17.6	14.5	0.2
Fat %	20.1	18.1	0.2

The high IGF-1 progeny grew significantly faster over the lifetime, but were significantly fatter at both sites.

Table 4. Average Test Performance Values for Both Groups.

Trait	High	Low	SEM
Test Growth Rate (gms/day)	790	825	13
Test Feed Intake (kg/day)	2.43	2.34	0.03
Test Feed Efficiency (kg feed/kg gain)	3.13	2.90	0.05
Fat Depth Third Last Rib(mm)	16.1	15.1	0.30
Loin Eye Depth(mm)	39.8	41.7	0.56

In Table 4 the average performance for both groups is presented for traits measured over the test period. In contrast to growth rate over the lifetime, over the test period the high group progeny grew significantly slower.

This group also consumed more feed, with the difference approaching significance (P<0.07). As a result the low group progeny were significantly more efficient than the high group. In terms of carcase measures, the low group were significantly leaner at the third last rib and had significantly larger loin eye depths.

Average meat quality values are presented for both groups in Table 5. There were no significant differences in any of the traits between the groups. Dressing percentage again approached significance at P<0.11.

Table 5. Average Meat Quality Values for Males and Females in Both Groups.

Trait	High	Low	SEM
Dressing Percentage	79.8	80.6	0.34
Colour Longdissimus Dorsi	53.5	53.1	0.60
Colour Super Spinalis	47.1	45.6	0.57
Ultimate pH	5.73	5.68	0.03

Outlined below in Table 6 are the actual and predicted differences recorded between the two groups (Low - High) for a number of traits.

Table 6. Realised and predicted responses and genetic correlations for a number of performance traits.

Trait	Realised	Predicted
IGF-1 (ng/ml)	-34	-25
Feed Efficiency (kg feed/kg gain)	-0.23	-0.22
Feed Intake (gms/day)	-60	-66
Growth Rate on Test (gms/day)	35	30
Growth Rate Over Life (gms/day)	-15	9
Fat Depth Last Rib (mm)	-1.9	-1.6

The results are in good agreement with what we would have expected from our initial studies. The 'realised genetic correlations' for feed efficiency, fat depth at the P2 site, and growth rate over the test period were 0.81, 0.4 and -0.35 respectively. The largest discrepancy was in growth rate over the lifetime, which in this study is unfavourable, even though growth rate over the test period remained favourable.

Conclusions

IGF-1 offers breeders a new cost effective selection tool to improve feed efficiency, leanness and growth rate. The major advantages ofIGF-1 over conventional selection methods are the age at which the trait can be measured and the relative ease and cost of measurement.

The early age at which IGF-1 can be measured will allow breeders to preselect candidate boars for further testing. In countries which castrate boars, a major saving will be realised on reducing the number of entire boars, not selected, which are sold as market pigs. Also breeders can further reduce costs by targeting boars for additional more expensive testing before making final selection decisions. Direct measurement of feed efficiency has been limited by breeders because of the costs involved in obtaining feed intake measures. Animals need to be individually housed or relative expensive electronic feeders are required. We have estimated the cost of obtaining individual intake measures to be approximately $20 per pig. The cost of measuring IGF-1 will be significantly less than this.

The use of IGF-1 for selection of livestock has been patented. A testing service, under the title PrimeGRO is currently available in Australia and will be available worldwide by the end of the year.