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ANIMAL GENETICS AND BREEDING UNIT
A joint unit of NSW DPI and UNE

Quantifying Meat and Eating Quality Differences between Major Australian Pig Genotypes

Technical Summary

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Background

This project had two primary objectives. The first objective was to quantify differences in meat and eating quality traits for the major terminal sire-line genotypes available to commercial producers. This would enable breeders to develop a "feel" for whether meat and or eating quality traits might be important for their breeding objectives, within and across sire breeds. In addition, objective characterisation of differences between sire genotype groups could establish whether there were likely to be detectable differences in their progeny's performance for meat and/or eating quality traits. Commercial producers could then consider whether sire breed choice, or even choice of individual sires, could alter meat and eating quality characteristics of the slaughter progeny they produce.

The second objective was to investigate the relationships between three temperament traits along with meat quality traits. Since the ability to obtain meat and eating quality data is currently limited, indirect selection criteria that are easily measured and correlated with these traits would be useful for improving response to selection for these traits. The three temperament traits investigated as candidate selection criteria included the back test (described by Hessing et al., 1993), activity while restrained in a weigh scale, and flight time. The back test is not a novel trait for pigs. It has been frequently recorded for behavioural studies, and has been associated with aggression tests, physiological response to stress, and immune response. However, data are somewhat limited, the trait is subjective in nature, and associations reported are not well supported by comparable studies. Further, the trait has not previously been demonstrated as heritable - only variable between individuals. In contrast, crate activity and flight time traits are novel traits for pigs, but are objective and have been consistently researched for cattle. Further, flight time and crate activity have been demonstrated to be heritable in cattle, and genetically correlated with some eating quality traits (Reverter et al., 2003; Kadel et al., submitted AJAR 2005). Investigating behavioural traits may also have some utility from the perspectives of animal welfare (Kanis et al., 2004), ease of handling and staff occupational health and safety.

Methodology

The first objective was achieved by generating a head to head comparison of slaughter progeny representing four different terminal sire genotype groups, SGG (Duroc: DU; Landrace: LR; Large White: LW; and Duroc Synthetic: DS). The term SGG is used in preference to "breed" because of the relatively small number of sires per breed evaluated. All slaughter progeny were generated using a common commercial sow base, were reared under a commercial environment, and recorded together at slaughter in the same abattoir. Sires included in these groups were generally available to commercial producers through AI (eg sires from National Pig Improvement Program members) or belonged to large integrated companies. Overall, 1169 progeny were recorded at the abattoir from 157 litters, representing 52 sires (9 DU, 16 LR, 17 LW and 10 DS sires).

The majority of these animals were recorded for hot standard carcase weight (HSCW: kg) and fat depth (CP2: P2 site, in mm). A smaller sub-sample (N~690) were more extensively recorded for meat and eating quality traits, including pH (pH) and colour (COL: meat lightness, Minolta L* value) recorded ~24 hours post slaughter, intra-muscular fat percentage (IMF) and various belly characteristics, along with percentage cooking loss (CL) and meat tenderness (SF: shear force, kg). Belly traits were established using image analyses, and included belly fat percentage predicted using the equation of Shaw and Rossetto (2003) (BF_E), or belly fat percentage based on visual area (BF_A), along with the percentage of lean in the streak (LSK) or percent lean+bone (LBP), also based on visual areas.

For the second project objective, three measures of temperament (two novel for pigs) were recorded in two breeding lines of pedigreed and performance recorded pigs, located at QAF Meat Industries, along with more limited meat quality data. The back test (BT) involved inverting young piglets (14-15 days old) for a 60 second period and subjectively counting the number of escape attempts. The specific holding procedure used in this study was determined from a preliminary trial comparing four alternative procedures, and was consistent throughout the project. Crate activity was defined as the standard deviation of 50 repeated weights (SDWT50, kg) recorded over a 20 second period. Flight time (FT, s) was the time taken to cover a distance of 1 metre after exiting from the weigh scale. Crate activity and flight time traits are objective measurements, but recorded at the start of the finishing period. These data were used to examine whether temperament traits were heritable in pigs when recorded under commercial conditions. Genetic correlations between temperament traits, production and meat quality traits were subsequently estimated.

Quantifying differences in meat and eating quality traits

Through designed matings, differences were quantified between progeny arising from different sire genotype groups (SGG), thereby meeting objective 1. Duroc Synthetic and DU sires produced progeny with heavier carcase weights (81.0 and 79.2 kg) than progeny of LW or LR sires (78.5 and 78.4 kg), when slaughtered at the same average age. Some of this production superiority may lie with the greater expected heterosis of progeny produced by sires with Duroc content, since the genetic background of the commercial sows was LW/LR. All SGG significantly differed from each other for carcase fat (P2 site), in the order DU>LR>LW>DS. Thus, progeny from purebred Duroc sires were fatter with respect to P2. The ranking of SGG for belly composition did not completely mirror differences in CP2. For example, while progeny of DS sires did not significantly differ from progeny of LW sires for belly fat traits (BF_E and BF_A); BF_E and BF_A were lowest for progeny of LW sires.

In addition to production related traits, significant differences between sire genotype groups were evident for some meat and eating quality traits. Progeny of purebred Duroc sires had higher IMF and more tender meat (lower SF), but more variable levels of cooking loss, than progeny representing sires from the alternative sire genotype groups. Least square means for DU were: 2.85% (IMF), 3.72 kg (SF) and 18.8% (CL). Favourable meat quality characteristics were not as evident in the leaner progeny of Duroc synthetic line sires (2.46% IMF, 4.03 kg SF), although SF values were higher for LW (4.28 kg) and LR (4.13 kg) sired progeny. Progeny of DS sires exhibited the lowest IMF levels (2.46%), consistent with their low CP2, and did not significantly differ in IMF from progeny of LW sires (2.59%). Progeny of LR sires exhibited lower levels of cooking loss (18.1%) and intermediate IMF (2.65%). While meat pH and colour did not significantly differ between sire genotype groups, variation between average progeny performance for individual sires was evident.

Meat and eating quality results were generally consistent, in trend, with those reported for comparable genotypes studied elsewhere, and would lead to differences between slaughter progeny genotype groups in acceptability of meat to consumers. This was demonstrated using criteria for consumer acceptability derived from a US source (Jennings et al., 2005?). Using specific thresholds for colour, intra-muscular fat and cooking loss percentages, DU and DS sired animals had a higher percentage (approximately 5-7%) of carcases meeting optimum levels for all three criteria. However, it is important to develop comparable criteria for Australian production and marketing systems, so that consumer acceptability can be adequately ascertained. This is also essential for determining which meat and/or eating quality traits should be targeted for change within breeding programs.

In addition to establishing differences between SGG, comparisons between sires also demonstrated that there was considerable overlap between sires for production and meat or eating quality traits from different sire genotype groups. Thus, it is also possible to identify sires with desirable meat quality characteristics within groups that exhibit less favourable meat quality characteristics overall, providing they have progeny or relatives recorded for meat and/or eating quality traits.

Temperament traits and their association with production and meat quality traits

The back test, crate activity and flight time traits were moderately heritable traits (h2: 0.31 0.09, 0.21 0.06, and 0.20 0.07) when measured under commercial conditions using defined procedures. Significant common litter effects were also evident for BT (c2: 0.08 0.04). However, the back test was uncorrelated with either flight time or crate activity measures, suggesting a different pattern of response to the restraint used for this trait. In contrast, crate activity and flight time measures were negatively correlated genetically (ra: -0.41 0.23) and phenotypically (rp: -0.18 0.03) with each other, such that animals with greater activity when constrained in a weigh crate also exit the crate at greater speed.

Generally, none of the temperament traits were strongly correlated with meat or eating quality traits. However, there was a consistent tendency for correlations of small magnitude but undesirable direction between measurements of temperament and some production traits, extending to inconsistently detrimental associations of small magnitude for meat quality traits. This trend between temperament and production traits was also reported by Hansson et al. (2005) for a separate population of animals. It suggests that selection for improved production will result in deterioration in behaviour of animals. This has implications for animal welfare, staff occupational health and safety and, perhaps in the future, greater implications for meat and eating quality traits.

Further work required

While the results for temperament traits considered in this study do not look particularly promising, results are not definitive. For example, it is plausible that the traits used in this study do not offer the best opportunities to evaluate differences between pigs in temperament. In particular, the back test is impractical, but was used to link previous studies with the current one. Secondly, the distance used for recording flight time is arbitrarily set, as is the number of weights recorded to currently define crate activity. Further, different aspects of temperament may be important for different reasons. For example, temperament characteristics important for ease of handling and improving animal and staff welfare may have little association with other temperament traits that could be associated with changes in meat physiology and quality. Finally, the associations observed could differ in other populations of pigs, or where slaughter conditions have greater impact on meat and eating quality traits. Thus, there is ample opportunity for extending knowledge in this area.

In addition, while not confined in usefulness to the genetics area, it is essential that parameters defining consumer acceptability of fresh pork products be clarified. Many Australian studies provide guidelines to establish dark firm and dry (DFD) or pale soft exudative (PSE) meat conditions. However, this establishes only undesirable extremes, and does not enable acceptability of meat to consumers to be adequately evaluated. Thus, the importance of changing various meat and eating quality traits to improve consumer eating experience remains undefined.

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