GENETIC RELATIONSHIPS BETWEEN INTRAMUSCULAR FAT CONTENT AND MEAT QUALITY, CARCASE, PRODUCTION AND REPRODUCTION TRAITS IN AUSTRALIAN PIGS

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SUMMARY
Intramuscular fat content was recorded on 1011 Large White, 870 Landrace and 186 Duroc pigs. All three breeds had a mean intramuscular fat content below the recommended level of 2.5% to improve eating quality with values of 1.59%, 1.68% and 2.47%, respectively. Heritability estimates were 0.29 for Large White and 0.42 for Landrace. Genetic correlations between intramuscular fat content and average daily gain, feed intake and backfat were -0.21, 0.03 and 0.19, respectively. Selection for higher leanness will therefore reduce intramuscular fat content. Intramuscular fat content was favourably correlated with the meat quality traits pH measured 45 minutes and 24 hours after slaughter (rₑ: 0.48 and -0.20) and drip loss percentage (rₑ: -0.06). A higher intramuscular fat content was genetically associated with a lighter colour (rₑ: 0.26). Considering reproduction traits, only litter birth weight was significantly related to intramuscular fat content (rₑ: -0.26 to -0.37).

Keywords: Pigs, intramuscular fat content, genetic parameters, meat quality

INTRODUCTION
To improve pork quality, most attention has been put on reduction of pork quality deficiencies pale, soft and exudative (PSE) and dark, firm and dry (DFD) meat. However, besides these important aspects of meat quality, eating quality of pork should not be neglected. This emphasizes the importance of intramuscular fat content since a higher intramuscular muscular fat content enhances eating quality of pork (Glodek et al., 1993). An intramuscular fat content of 2.5% is recommended (de Vol et al., 1988). Intramuscular fat content is unfavourably correlated with backfat (rₑ: 0.42) as reviewed by Hermesch (1996) and therefore selection for increased leanness reduces intramuscular fat content with the consequence that most breeds have an intramuscular fat content below 2.5% (Glodek et al., 1993). The aim of this study was to evaluate the intramuscular fat content level in some lines of Australian pigs, to estimate heritabilities for this trait and analyze genetic relationships to other economically important performance traits.

MATERIAL AND METHODS
Intramuscular fat content was obtained from the m. longissimus dorsi applying two measurement techniques; ether extraction and spectroscopy using a NIR infrared machine. In total 1011 Large

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White, 870 Landrace and 186 Duroc pigs representing three lines of pigs at Bunge Meat Industries had information available on this trait (Table 1), with the mean being 1.59%, 1.68% and 2.47% at an average animal weight at slaughter of 100 kg for these three breeds, respectively. These animals were a subset of 3600 boars who had production, carcase and meat quality traits recorded. The traits presented in this study have been described by Hermesch et al. (1995) along with the model which was applied to each trait. Information about reproductive performance of the sow was obtained from herd recording system of Bunge Meat Industries. A description of this data was presented by Tholen et al. (1996) and included 6050 sows which farrowed between 1990 and 1995.

Table 1. Number of records (N), means, raw standard deviations (s.d.) for intramuscular fat content for Large White, Landrace and Duroc pigs

<table>
<thead>
<tr>
<th>Breed</th>
<th>N</th>
<th>Mean</th>
<th>s.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large White</td>
<td>1011</td>
<td>1.59</td>
<td>0.62</td>
</tr>
<tr>
<td>Landrace</td>
<td>870</td>
<td>1.68</td>
<td>0.63</td>
</tr>
<tr>
<td>Duroc</td>
<td>186</td>
<td>2.46</td>
<td>0.81</td>
</tr>
</tbody>
</table>

The fixed effect part of the model was derived using the SAS procedure PROC GLM (SAS, 1991). Significant fixed effects for intramuscular fat content included slaughter day, breed, measurement technique and hot carcase weight which was fitted as a linear covariate. These fixed effects explained 20% of the total variation. Random effects fitted in the model for intramuscular fat content included additive genetic and residual effects. A further description of the applied model and the estimation procedure was given by Hermesch et al. (1997) in these proceedings.

RESULTS AND DISCUSSION

Heritabilities. The number of records did not allow a separate analysis for the Duroc breed and heritabilities were therefore only estimated for Large White and Landrace. Heritability estimates were 0.29 and 0.42 for intramuscular fat content for these two breeds (Table 2). These estimates are in agreement with a mean literature heritability estimate of 0.45 as reviewed by Hermesch (1996).

Table 2. Heritabilities (h^2) with standard errors (s.e.) and variance components for intramuscular fat content for Large White and Landrace pigs

<table>
<thead>
<tr>
<th>Breed</th>
<th>h^2</th>
<th>s.e. of h^2</th>
<th>σ^2_a</th>
<th>σ^2_e</th>
<th>σ^2_p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large White</td>
<td>0.29</td>
<td>0.09</td>
<td>0.096</td>
<td>0.238</td>
<td>0.334</td>
</tr>
<tr>
<td>Landrace</td>
<td>0.42</td>
<td>0.11</td>
<td>0.144</td>
<td>0.199</td>
<td>0.343</td>
</tr>
</tbody>
</table>

Correlations. To estimate genetic correlations, Large White and Landrace pigs were pooled and estimates of correlations between intramuscular fat content and average daily gain recorded in the boar test station (ADGT), feed intake (FDINT), backfat (BF) and the meat quality traits pH recorded 45 minutes and 24 hours after slaughter (pH45, pH24), colour of the m. longissimus dorsi (CLD) and drip loss percentage (DLP) are presented in Table 3. The estimated genetic correlation

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between intramuscular fat content and average daily gain was -0.21. Although no approximation of the standard error could be obtained, it is expected to be of the same magnitude, taking the low heritability of average daily gain (Hermesch et al., 1995) into account. No genetic relationship was found between feed intake and intramuscular fat content, while selection for reduction of backfat is accompanied by a reduction in intramuscular fat content. The magnitude of this unfavourable relationship is lower in this study than in the review by Hermesch (1996) (r_g: 0.44).

Generally, genetic correlations between intramuscular fat content and meat quality traits were favourable with respect to PSE and DFD meat. A higher intramuscular fat content was genetically accompanied with a higher pH45 (r_g: 0.48), a slightly lower drip loss percentage (r_g: -0.06) and a lighter colour (r_g: 0.26). Generally, a lighter colour is an attribute of PSE meat. However, the lighter colour of m. longissimus dorsi in pigs with higher intramuscular fat content might be due to the lighter colour of fat and therefore should not be regarded as PSE meat. DFD is characterized through a high pH 24 hours after slaughter. Therefore, the low negative correlation between intramuscular fat content and pH24 is favourable.

In the review by Hermesch (1996) average literature values of genetic correlations between intramuscular fat content and pH45 and drip loss percentage were 0.25 and -0.15, thus supporting estimates found in this study. However, estimates of genetic correlations with pH24 and colour had a wide range between reviewed studies and genetic correlations between intramuscular fat content and pH24 and colour found in this study were within the range of these literature values.

Since intramuscular fat content and reproduction traits were measured on different animals, no estimates of environmental and therefore phenotypic correlations could be obtained. Genetic correlations could be estimated through the relationship matrix and are presented in Table 4. Estimates of genetic correlations between intramuscular fat content and reproduction traits ranged from -0.11 to 0.11 for number born alive in the first to third parity. However, given the standard errors for these genetic correlations, these estimates were not significantly different from zero. In contrast, litter birth weight was genetically correlated with intramuscular fat content with estimates ranging from 0.37 in the first parity to 0.26 in the third parity. The third reproduction trait was derived from litter birth weight and number of piglets born alive and estimates of genetic
correlations ranged from -0.19 to -0.12 for the first three parities. No literature estimates of genetic correlations are available for these combinations of traits.

Table 4. Genetic correlations between intramuscular fat content and reproduction traits number born alive (NBA), litter birth weight (LBW) and average piglet weight at birth (ABW) with standard errors (s.e.) recorded in the first to third parity

<table>
<thead>
<tr>
<th></th>
<th>NBA</th>
<th>s.e.</th>
<th>LBW</th>
<th>s.e.</th>
<th>ABW</th>
<th>s.e.</th>
</tr>
</thead>
<tbody>
<tr>
<td>First parity</td>
<td>-0.11</td>
<td>0.14</td>
<td>-0.37</td>
<td>0.13</td>
<td>-0.15</td>
<td>0.13</td>
</tr>
<tr>
<td>Second parity</td>
<td>0.08</td>
<td>0.14</td>
<td>-0.32</td>
<td>0.12</td>
<td>-0.19</td>
<td>0.14</td>
</tr>
<tr>
<td>Third parity</td>
<td>0.11</td>
<td>0.18</td>
<td>-0.26</td>
<td>0.15</td>
<td>-0.12</td>
<td>0.18</td>
</tr>
</tbody>
</table>

*standard errors obtained from approximation of Robertson (1959)*

**Strategies** Pork has to compete with other food. Therefore meat and eating quality and consumer satisfaction are important. A high intramuscular fat content improves eating quality and could be used as an indirect trait to select for eating quality. The current level of intramuscular fat content is below the recommended level and a further reduction can be expected with continuing selection for higher leanness. To avoid further decrease, intramuscular fat content should be considered in breeding programmes. One possibility is to incorporate Duroc pigs in crossbreeding programmes. However, given the average intramuscular fat content in Duroc of 2.46%, the recommended level of 2.5% will not be achieved this way. Another possibility is genetic improvement through selection. Genetic correlations with other performance traits are low, limiting possibilities of indirect selection. The measurement techniques for intramuscular fat content applied in this project are not feasible for general performance recording. Therefore, developments in real time ultrasound techniques and video image analysis might allow the possibility to record intramuscular fat content on the live animal and the carcass.

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**REFERENCES**