Maximising energy intake and growth potential of entire male pigs

Frank R. Dunshea

Professor and Chair of Agriculture, Faculty of Land and Food Resources, The University of Melbourne, Parkville, Victoria 3030, Australia

Adjunct Professor, School of Veterinary and Biomedical Science, Murdoch University
Adjunct Professor, School of Chemistry and Biological Sciences, Deakin University
Why not castrate pigs?

• To take advantage of the high potential for lean tissue deposition in boars
Castration reduces lean tissue deposition at high weights.

Suster et al. (2006)
Why not castrate pigs?

- To take advantage of the high potential for lean tissue deposition in boars
- To reduce carcass fat and back fat depth
Castration increases P2 back fat

Dunshea et al. (2001)
Why not castrate pigs?

• To take advantage of the high potential for lean tissue deposition in boars
• To reduce carcase fat and back fat depth
• To improve feed conversion efficiency
Physically castrated barrows are less efficient than entire males (ca. 11%) from weaning to market.
Entire males have lower carcass weight, back fat and finisher feed intake and FCR compared to physically castrated barrows

<table>
<thead>
<tr>
<th></th>
<th>Effect</th>
<th>sed</th>
<th>95% Cl</th>
<th>P-value</th>
<th># studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG (g/d)</td>
<td>-31</td>
<td>15.5</td>
<td>(-61.4, -0.58)</td>
<td>0.011</td>
<td>8</td>
</tr>
<tr>
<td>ADFI (g/d)</td>
<td>-467</td>
<td>30.9</td>
<td>(-531, -404)</td>
<td>&lt;0.001</td>
<td>7</td>
</tr>
<tr>
<td>FCR</td>
<td>-0.48</td>
<td>0.030</td>
<td>(-0.54, -0.42)</td>
<td>&lt;0.001</td>
<td>7</td>
</tr>
<tr>
<td>Carcass weight (kg)</td>
<td>-2.14</td>
<td>0.656</td>
<td>(-3.43, -0.86)</td>
<td>&lt;0.001</td>
<td>10</td>
</tr>
<tr>
<td>Back fat (mm)</td>
<td>-4.9</td>
<td>0.29</td>
<td>(-5.05, -3.93)</td>
<td>&lt;0.001</td>
<td>10</td>
</tr>
</tbody>
</table>

Dunshea (2010)
Why not castrate pigs?

- To take advantage of the high potential for lean tissue deposition in boars
- To reduce carcass fat and back fat depth
- To improve feed conversion efficiency
- To reduce cost of production and increase returns
- To improve animal welfare
The animal welfare dilemma

• Castration without anaesthesia is viewed as painful and a welfare risk

but

• Group-housed boars can exhibit negative behaviours that can be a welfare risk and can limit feeding intake and growth performance
Castration decreases mounting behaviour

Cronin et al. (2003)
Castration decreases aggression

Cronin et al. (2003)
Castration reduces fighting lesions

Dunshea et al. (2011)
Castration reduces the proportion of pigs with high fighting lesion scores

Dunshea et al. (2011)
Group-housed entire males grow less than their potential

Dunshea et al (2011)
Group-housed entire males but not barrows grow less than their potential potential.

Suster et al. (2006)
Effects of increasing energy intake or available energy depends on species and physiological state

1 Supports increased carcass lean gain
   - Chicken, Growing Pig, Young ruminant

2 Supports increased carcass fat gain
   - Finishing ruminant, high appetite pig

More fat growth

More lean growth
Better efficiency
Protein deposition increases linearly with energy intake in improved pigs

King et al. (2005)
Feed intake may limit protein deposition in improved pigs under commercial conditions

King et al. (2005) & Dunshea (2005)
Boars have a higher lysine requirement than barrows and gilts

Figure 2 Relationship between estimated standardized ileal digestible (SID) lysine content (g/MJ DE) and BW in boars (solid line), barrows (dashed line) and gilts (dotted line). Estimates were obtained from InraPorc (van Milgen et al., 2008) simulations of performance data (after Quiniou et al., 2010).
How we mitigate against the negative behaviours and maintain available energy in boars

- Provide adequate access to feeders and drinkers
- Do not overstock and avoid remixing
- Provide comfortable environment and reduce risk of disease
- Dietary betaine to reduce energy expenditure
- Dietary enzymes to release nutrients from feed
- Dietary neuroleptics to control behaviour
- Immunocastration to control behaviour
How we mitigate against the negative behaviours and maintain available energy in boars

- Provide adequate access to feeders and drinkers
- Do not overstock and avoid re-mixing
- Provide comfortable environment and reduce risk of disease
- Dietary betaine to reduce energy expenditure
- Dietary enzymes to release nutrients from feed
- Dietary neuroleptics to control behaviour
- Immunocastration to control behaviour
Hyperosmotic stress and compensation with ion pumps

- **Water balance maintained**
- **Cell volume maintained**
- **High energy cost**
- **Depressed metabolism**
- **Increased electrolyte concentration in the cell**

**Ion pumps**
Hyperosmotic stress, compensation with ion pumps and betaine

Water balance maintained

Cell volume maintained

Lower energy cost

Stable electrolyte concentration in the cell

Stable metabolism

Betaine

Ion pumps
Dietary betaine increases the intercept of the relationship between energy intake and energy deposited in pigs by 0.5 MJ/d.

Dunshea et al (unpublished)
Dietary betaine decreases maintenance requirements (-10%) in growing pigs

Campbell et al. (unpublished)
Betaine increases daily gain in restrictively fed (ca 2.7 kg/d) but not ad libitum fed (3.4 kg) pigs

Suster et al. (2006b)
Betaine increases lean gain in gilts and boars fed 80% (2.5 kg/d) ad libitum

Dunshea et al (2009)
Betaine and xylanase have additive effects on daily gain in gilts fed 80% ad libitum (2.7 kg/d)

Dunshea (unpublished)
Immunization against GnRF and physical castration reduce aggression

Cronin et al. (2003)
Table 1  Average fixed effects of immunization against GnRF (immunized males – entire males) from meta-analyses of data from peer reviewed studies (n = 19) with group-housed pigs.\(^{a,c}\)

<table>
<thead>
<tr>
<th>Trait</th>
<th>Effect</th>
<th>s.e.d.</th>
<th>95% confidence interval</th>
<th>P-value</th>
<th># studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG (g/d)</td>
<td>119</td>
<td>8.9</td>
<td>(102, 136)</td>
<td>&lt;0.001</td>
<td>17</td>
</tr>
<tr>
<td>ADFI (g/d)</td>
<td>429</td>
<td>26.8</td>
<td>(376, 482)</td>
<td>&lt;0.001</td>
<td>12</td>
</tr>
<tr>
<td>FCR</td>
<td>0.11</td>
<td>0.02</td>
<td>(0.07, 0.15)</td>
<td>&lt;0.001</td>
<td>14</td>
</tr>
<tr>
<td>Live weight (kg)</td>
<td>2.96</td>
<td>0.43</td>
<td>(2.12, 3.80)</td>
<td>&lt;0.001</td>
<td>16</td>
</tr>
<tr>
<td>Carcass weight (kg)(^d)</td>
<td>2.09</td>
<td>0.35</td>
<td>(1.38, 2.94)</td>
<td>&lt;0.001</td>
<td>17</td>
</tr>
<tr>
<td>Dressing percentage</td>
<td>-0.29</td>
<td>0.12</td>
<td>(-0.51, -0.07)</td>
<td>&lt;0.001</td>
<td>11</td>
</tr>
<tr>
<td>Back fat (mm)</td>
<td>1.53</td>
<td>0.18</td>
<td>(1.16, 1.89)</td>
<td>&lt;0.001</td>
<td>14</td>
</tr>
</tbody>
</table>

ADG = average daily gain; ADFI = average daily feed intake; FCR = feed conversion ratio.

Dunshea et al. (2013)
Dietary neuroleptics

- Dietary tryptophan has been shown to increase brain serotonin, decrease aggression and improve meat quality.

- Bromide has been used as a sedative and anti-epileptic in humans and was common in the mid 20th century (Bromo-Seltzer was a common over-the-counter remedy in the 1930s and 1940s).

- Bromide tea was widespread in WW1 and WW2 as it was believed to reduce the sexual desire of servicemen.

- Dietary neuroleptics may provide a dietary means of reducing sexual and aggressive activities and increasing growth performance.
Dietary neuroleptics can increase carcass weight and dressing rate in males

Table 1. Effect of sex and dietary additives over the finisher phase between 17 and 22 weeks of age on final weight and carcass characteristics at slaughter (after McCauley at al. 2003a and unpublished)\textsuperscript{A}

<table>
<thead>
<tr>
<th></th>
<th>Boars</th>
<th>Anti-GnRF</th>
<th>Barrow</th>
<th>LSD\textsuperscript{B}</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control Mg Br Trp</td>
<td>GnRF Barrow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final weight (kg)</td>
<td>93.7\textsuperscript{a} 95.2\textsuperscript{a} 97.9\textsuperscript{ab} 94.1\textsuperscript{a}</td>
<td>99.8\textsuperscript{b}</td>
<td>99.3\textsuperscript{b}</td>
<td>4.66</td>
<td>0.04</td>
</tr>
<tr>
<td>Carcass weight (kg)</td>
<td>69.0\textsuperscript{a} 71.3\textsuperscript{ab} 74.1\textsuperscript{b} 71.0\textsuperscript{ab}</td>
<td>73.7\textsuperscript{b}</td>
<td>76.8\textsuperscript{b}</td>
<td>4.62</td>
<td>0.05</td>
</tr>
<tr>
<td>Dressing (g/kg)</td>
<td>751\textsuperscript{a} 761\textsuperscript{b} 761\textsuperscript{b} 760\textsuperscript{b}</td>
<td>755\textsuperscript{a}</td>
<td>773\textsuperscript{c}</td>
<td>8.7</td>
<td>0.009</td>
</tr>
<tr>
<td>P2 back fat (mm)</td>
<td>10.6\textsuperscript{a} 11.0\textsuperscript{a} 11.1\textsuperscript{a} 10.3\textsuperscript{a}</td>
<td>11.7\textsuperscript{a}</td>
<td>15.6\textsuperscript{b}</td>
<td>1.36</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

\textsuperscript{A} Anti-GnRF injections were given at 13 and 17 weeks of age.
\textsuperscript{B} Least significant difference (P=0.05) between treatment groups.
Dietary neuroleptics and immunization against GnRF can increase daily gain in entire males

Growth performance: 17 - 22 weeks

Dunshea et al. (unpublished)
Dietary neuroleptics and immunization against GnRF can increase daily gain in heavy entire males

Growth performance: 17 - 22 weeks

Dunshea et al. (unpublished)
Conclusion

• Physical castration of male pigs results in reduced feed efficiency and lean deposition and excess deposition of fat

• Performance of group-housed entire males over the late finishing period is less than potential, possibly because of aggressive and sexual behaviours

• Modern improved entire male pigs are generally constrained by energy (and possibly other nutrient) intake under commercial conditions

• Management and nutritional strategies (e.g. betaine, enzymes) that maximise energy intake or energy availability can overcome some constraints under commercial conditions

• Dietary neuroleptics and immunization against GnRF may provide means of reducing sexual and aggressive activities and increasing growth performance