Pork production with immunocastration: welfare and environment

Volker Stefanski¹, Etienne Labussière², Sam Millet³, Ulrike Weiler¹
Challenge pork production

In the EU, about 75 % of male piglets are surgically castrated.

Surgical castration serves to prevent off-odour in meat from male pigs, but causes strong public disapproval, as it is painful and considered a welfare problem.

Pork production with entire males has long been regarded as an alternative, but problems with meat quality and welfare issues remain.

→ Immunocastration (IC) could be a serious alternative with potential advantages on animal welfare, ecology and economy.
Sustainable pork production with IC

1. No painful castration, no climate-relevant gases (isoflurane anesthesia)
2. Less animal welfare problems
3. Feed efficient & potentially environmentally friendly
4. High meat quality, higher number of usable carcasses
5. Preconditions
   - optimization of the production process
   - confirmation of reliability ("non-responder")
   - consumer acceptance
ERA-Net SuSI addresses research gaps

**Sustainability in pork production with immunocastration**

→ Evaluation and optimization of pork production with immunocastration as an environmentally, economically and socially sustainable alternative

### Coordination UHOH (Stefanski)

<table>
<thead>
<tr>
<th>Trial A1 &amp; A2 (INRA)</th>
<th>Feed Intake and Nutrient Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial B1 &amp; B2 (UHOH)</td>
<td>Housing and Stress</td>
</tr>
<tr>
<td>Trial C (ILVO)</td>
<td>Diet and Timing of Vaccination</td>
</tr>
<tr>
<td>Trial D (SEGES)</td>
<td>Productivity</td>
</tr>
<tr>
<td>Trial E (KIS)</td>
<td>Processing aptitude</td>
</tr>
<tr>
<td>Trial F (ILVO, WULS)</td>
<td>Consumer Acceptance</td>
</tr>
</tbody>
</table>

### Data Sources

<table>
<thead>
<tr>
<th>WP 1 (INRA)</th>
<th>On-Farm Management: Nutrition (Labussiere)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP 2 (UHOH)</td>
<td>On-Farm Management: Health and Welfare (Stefanski, Hölzle, Huber)</td>
</tr>
<tr>
<td>WP 3 (KIS)</td>
<td>On-Farm Management: Meat Quality (Candek-Potokar, Vrecl)</td>
</tr>
<tr>
<td>WP 4 (ILVO)</td>
<td>Social and Consumer Acceptance (Aluwé, Zakowska-Bieman)</td>
</tr>
</tbody>
</table>

### WP 5 (ILVO) Environmental Sustainability (Millet)

### WP 6 (SEGES) Economical Sustainability (Maribo)

### WP 7 (WU) Social Sustainability (Ingenbleek)

### WP 8 (UHOH) Dissemination/Communication (Weiler)

**Continuous Interchange: Farmers Organisation, Feed Companies, Breeders, Retailers, Meat Processors,...**
Impact of immunocastration (IC) on

(1) welfare (behavior & health)

(2) nutritional efficiency & environmental footprint
How does immunocastration work?

Vaccination with anti-GnRH vaccine (Improvac©)

Injection at two time points (V1 & V2)

Age in weeks
Effect of IC on welfare $\rightarrow$ behavior & health

State of the art

- IC show less aggressive and sexual behavior than EM, e.g. Rydmer et al. 2010 (Sweden), Karaconji et al. 2015 (Australia), Puls et al. 2017 (USA)

- Penile injuries in entire males are abundant, e.g. Weiler et al. 2016

Research gaps

- IC behavior: Stability under varying / stressful housing conditions

- Effect on IC on penile injuries (and other health-related problems such as ulcers, leg problems)
Behavior of IC (SuSI project)

- Less sexual behavior

- Effect on aggressive behavior may depend on the housing environment
  - Final analysis with full SuSI data set; further research

**Immunocastrates vs. entire males**

- Less sexual behavior

H-test with pairwise comparison (Bonferroni-corrected)

Preliminary data from SuSI project showing 50% of the final data set
Health - Penile injuries in IC (SuSI project)

Prevalence

<table>
<thead>
<tr>
<th>% of animals injured</th>
<th>IC</th>
<th>Entire males</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 / 24</td>
<td>16 / 24</td>
</tr>
</tbody>
</table>

Chi-square: p < 0.05

Severity

<table>
<thead>
<tr>
<th>Injuries (score class)</th>
<th>IC</th>
<th>Entire males</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td></td>
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<tr>
<td>1.5</td>
<td></td>
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<tr>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MW-U-Test: p < 0.05

Data from SuSI project showing 50 % of the final data set

IC vs. entire males
- Less frequent and less severe penile injuries

Kress et al. 2018
Nutritional efficiency & environmental footprint

State of the art

“In terms of feed consumption, immunocastrates can be considered boars until the second vaccination, after which their feed intake increases drastically” (Millet et al. 2018)

Research gaps

- Innovative feeding concepts
- Optimized feeding strategies to minimize environmental impact
### Nutritional efficiency of IC

<table>
<thead>
<tr>
<th></th>
<th>Barrow</th>
<th>IC</th>
<th>Boar</th>
<th>r.s.d.</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily gain, kg</td>
<td>0.72</td>
<td>0.72</td>
<td>0.72</td>
<td>0.07</td>
<td>0.987</td>
</tr>
<tr>
<td>Daily feed intake, kg</td>
<td>2.00</td>
<td>1.84</td>
<td>1.83</td>
<td>0.24</td>
<td>0.005</td>
</tr>
<tr>
<td>Gain: feed, g/g</td>
<td>0.36</td>
<td>0.40</td>
<td>0.41</td>
<td>0.21</td>
<td>0.005</td>
</tr>
<tr>
<td>Carcass yield, %</td>
<td>78.9</td>
<td>77.2</td>
<td>77.9</td>
<td>1.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lean meat, %</td>
<td>60.5</td>
<td>61.1</td>
<td>62.4</td>
<td>3.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Meat thickness, mm</td>
<td>66.7</td>
<td>66.6</td>
<td>64.9</td>
<td>7.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fat thickness, mm</td>
<td>14.7</td>
<td>13.8</td>
<td>12.1</td>
<td>3.4</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

abc Within a row, means without a common superscript differ (P <0.05).

Aluwé et al., 2015

### IC vs. barrows

- Better feed conversion ratio
- Higher lean meat in %
- Lower carcass yield = less feed per kg meat?

➢ Opportunities for optimisation, adjustment of diet after V2
Environmental footprint of IC

IC vs. barrows

- Lower carbon food print of the feed intake/ kg carcass weight
- Higher nitrogen efficiency
  ➢ IC are ecologically more efficient than barrows

But this may depend on the feeding strategy
  ➢ Opportunities for optimisation
Effect of IC on energy intake and nutrient deposition

Energy intake

ME intake (MJ/d)

+40%

Days relative to V2

Energy disposition

Lipid deposition

Protein deposition

Utilization of dietary amino acids

Std digestible lysine (g/d)

Lysine intake - in ad libitum fed animals - diet at 8.7 g Lys/MJ ME

Lysine requirements

INRA, unpublished; Labussière et al., 2014; Batorek et al., 2016
Effect of IC on energy intake and nutrient deposition

**Optimized feeding of IC until second week after V2**

Standard finishing diet for boars is adequate

- High protein deposition capacity (compared to castrates)
- Better feed conversion ratio (compared to castrates)

**Optimized feeding of IC after second week after V2**

- Protein content should be reduced to limit protein catabolism and spillage
- Reduces nitrogen excretion

**Research gap**

Possible interaction between feeding level and protein utilization
Opportunities in pork production with IC

Opportunities

➢ Welfare advantages of IC for animal-friendly pork production

➢ Exploit the ecological advantages of IC

➢ Exploit the economical advantages of IC

Current drawbacks

➢ Research gaps with respect to optimized management (e.g. housing, feeding, reliability and time point of vaccination)

➢ Consumer and market reservations in some countries
Thanks to funders and partners
Experimental design

- Two rounds: 384 experimental animals (96/sex)
- Danish sow x Belgian Piétrain sire
- **4 sexes:** entire males (Em), barrows (Ba), immunocastrates (Ic) and gilts (Gi)
- Grouphousing: 4 animals (same sex) per pen
- *Ad libitum* feeding
- **3 phase feeding strategy,** phase 3 adapted for barrows
- Desk study: hypothetical soybean-free feed for phase 3
- Start weight: 25kg
- **Slaughter weight:** 99kg - 138kg
$\frac{\text{CFP}_{\text{feed}}}{\text{KG FEED}} \times \text{FEED INTAKE} = \text{CFP}_{\text{feed intake}}$

$\frac{\text{CFP}_{\text{feed intake}}}{\text{kg carcass weight}}$
Van den Broeke et al., 2017

Experimental design

Start trial

- 72 pens of 4 piglets
- Same sex /pen
- EM
- Barrows
- IC
- Gilts
- 25 kg at start trial

During trial

- Pigs fed *ad libitum*
- Multiphase feeding regime
- Weekly weighing:
  - Growth
  - Feed intake
  - Gain to feed ratio

Slaughter

- 105 kg
- 117 kg
- 130 kg

3 slaughter weights
Van den Broeke et al., 2017

Nutrient content pig

6 pigs/treatment (sex x slaughter weight) euthanized = 1 pig per pen

Carcass grinded
Representative subsample of 10 kg collected

Subsample autoclaved, mixed, lyophilized and analysed

Body composition: Water, crude protein, crude fat, crude ash, total phosphorus concentration
Calculation of N- and P- efficiency

Nutrient efficiency = nutrient accretion / nutrient intake

Nutrient intake = feed ingested × nutrient content feed

Nutrient accretion = [(mean bodyweight pen at slaughter × nutrient content pig) - (mean bodyweight pen at start × nutrient content piglet)]