An Alternative to Castration of Pigs – Immunological Control of Boar Taint

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What is Boar Taint? Why is it important?

- Pork from sexually maturing male pigs can exhibit an offensive odor during cooking or eating (= boar taint)

- Primary compounds responsible:
  - Androstenone (testicular steroid, pheromone)
  - Skatole (formed in gut as a microbial by-product of tryptophan metabolism)

- Sensory detection depends upon the levels on these compounds in the carcass and on consumer sensitivity:
  - High proportion (>50%) of consumers are moderately to highly sensitive (women more so than men)

- A food quality (pork acceptability) problem that has to be managed
Strategies to Manage Boar Taint (1)

- **Physical castration at early age:**
  - Very effective, ≈ 99% (occasional cryptorchids/incomplete castrations/intersex pigs)
  - Approx. 95% of male pigs raised globally are castrated each year (i.e., approx. 500 million)
    - Virtually all without any form of anaesthesia or analgesia
    - Subject to welfare legislation in the EU
  - Due to elimination of testicular anabolic steroids, natural growth performance is suppressed
  - Sub-optimal for sustainability

- **Early slaughter:**
  - This method is practiced in UK, Ireland, parts of Spain, Australia
  - Not effective in early maturing pigs
  - Limits slaughter weight and production efficiency
  - Sub-optimal for sustainability
Strategies to Manage Boar Taint (2)

- Immunological castration (GnRF-conjugate):
  - ≈99% effective (and treats cryptorchids missed by physical castration)

- Future possibilities:
  - Genetic selection (to reduce propensity for taint)
  - Semen sexing (production of females or males?)

Neither practically feasible in near to mid-term future
Immunological castration: an attractive alternative to physical castration

- **Improved productivity**
  - Pigs are immunized close to slaughter and therefore are raised as entire males for most of production period:
    - Reduced mortality and disease attributed to physical castration
    - Better feed:gain conversion with higher lean yields and same meat quality (no taint).

- **Improved environmental impact**
  - Lower feed consumption and decreased effluent

  - **Both contribute to sustainability**
So, what is this ‘GnRF Conjugate’ product?

- It’s an injectable immunological product
  - Antigen is a synthetic incomplete analog of GnRF conjugated to a larger carrier protein
  - Adjuvanted aqueous formulation
- Two doses SC in the neck, at least 4 weeks apart; administration of the second dose 4-6 weeks prior to slaughter
  - **First dose** has no effect on testicular function but simply primes the immune system
  - **Second dose** stimulates production of antibodies to pig’s GnRF, causing temporary inactivation of testicular function leading to:
    - Reduction of primary compounds causing boar taint (androstenone & skatole)
    - Behavioral control
Mode of Action

Hypothalamus
Brain
Pituitary

GnRF

LH & FSH

Testes

Fertility
Libido
Behaviour
Androstenone

Many steroids

Skatole

Anti-GnRF antibodies

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Mode of Action

Hypothalamus → GNRF → Pituitary → LH & FSH → Testes

- Anti-GnRF antibodies
- Fertility
- Libido
- Behaviour
- Androstenone
- Skatole
- Many steroids
**Mode of Action**

- **Hypothalamus**
- **Brain**
- **Pituitary**
- **GnRF**
- **LH & FSH**
- **Testes**
- **Anti-GnRF antibodies**

- **Fertility**
- **Libido**
- **Behaviour**
- **Androstenone**
- **Skatole**
- **Many steroids**

- Same mode of action as physical castration
Antibody Production and Taint Control

- 1st dose: primes the immune system
- 2nd dose: peak antibody levels occur about 7 days later
- Protective antibody levels last until ca. 8 weeks after the 2nd dose
- Testosterone and taint is suppressed for at least 8-10 weeks

The profile of production of antibodies against GnRF

- Level of Boar Taint
- Protective level of antibodies
- Level of immunity

Minimum Interval of 4 weeks

1st Dose
2nd Dose

Weeks after 2nd dose

Recommended time for slaughter

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How effective is it?

- GnRF Conjugate is highly effective in suppressing testicular function and controlling boar taint
- In global studies >99% effective
  - Primary variables measured:
    - Boar taint (chemical and sensory)
    - Testosterone levels
  - Other variables include:
    - Testes size
Background Taint in Barrows, Gilts, Sows and Boars: US Survey 2005

180 barrows & 180 gilts, 120 sows & 120 boars surveyed from US slaughter plants (Nederveld et al; IPVS 2006)
Efficacy of GnRF Conjugate: 4 European studies (Spain, Germany, Denmark, Hungary - 2005-07)

Skatole Concentration (ng/g) vs. Androstenone Concentration (ng/g)

- Barrows (454)
- IC (479)
- Entire Boar (153)*

*several off the chart

Pfizer data on file
- Immunization causes a decrease in testes size

- Testes size (paired width) significantly less (P<0.01) at 2 and 4 wks post 2\textsuperscript{nd} dose

Efficacy – Effect on Testes Size

- A typical difference in testes size

Boar  IC pig

Pigs ~100-105 kg live weight and ~23 weeks of age
Efficacy – Effect on Testes Size

- Smaller testes size following immunization can be used to assess compliance and efficacy on both the live pig and ....

Pigs ~100-105 kg live weight and ~23 weeks of age
Efficacy – Effect on Testes Size

- Testes are visibly smaller within 2 weeks of second dose
Efficacy – Sensory studies

- Twenty studies conducted globally:
  - 12 consumer panels
  - 8 expert or trained panels
- All demonstrate pork from IC pigs to be indistinguishable from pork from barrows or females
Consumer Attitudes

- EUROBAROMETER

- SWEDISH CONSUMER RESEARCH

- SWISS CONSUMER RESEARCH
  - Understanding Consumer Attitudes Towards Vaccination to Control Boar Taint (2007)

- FRANCE, GERMANY, AND NETHERLANDS CONSUMER RESEARCH
  - Understanding Consumer Attitudes Towards Vaccination to Control Boar Taint (2008)
Consumer Market Research in Europe

- Existing knowledge of boar taint and means of control extremely low
- Vaccination to control boar taint is clearly more acceptable and overwhelmingly preferred over physical castration, even with the use of anesthesia.
- Nearly all pork consumers were accepting of eating pork from vaccinated pigs.
- Moreover, nearly half claimed they would seek out pork from vaccinated pigs and would prefer to only eat pork produced using this method.
- These findings were similar across markets.
Performance - Intact Boar vs. Physical Castrate

Lean Tissue Deposition Rate

Feed Conversion Rate

Source: R Campbell, 1999
### Growth performance & carcass quality

#### IC pigs vs. barrows: % improvement

<table>
<thead>
<tr>
<th>% Improvement relative to physical castration</th>
<th>Slaughter Weight (kg)</th>
<th>Feed Effic (%)</th>
<th>Daily Gain (%)</th>
<th>Lean meat (%)</th>
<th>Backfat p2 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1 (24) – Mexico</td>
<td>108 -110</td>
<td>7.7*</td>
<td>NS</td>
<td>7.7*</td>
<td>22.4*</td>
</tr>
<tr>
<td>Trial 2 (30) – Australia</td>
<td>~105</td>
<td>15.1*</td>
<td>6.8*</td>
<td>ND</td>
<td>7.2*</td>
</tr>
<tr>
<td>Trial 3 (50) # – Australia</td>
<td>96 -100</td>
<td>10.0*</td>
<td>NS</td>
<td>ND</td>
<td>17.4*</td>
</tr>
<tr>
<td>Trial 4 (50) # – Australia</td>
<td>113 -120</td>
<td>16.9*</td>
<td>NS</td>
<td>ND</td>
<td>11.7*</td>
</tr>
<tr>
<td>Trial 5 (260) – Switzerland</td>
<td>100 -110</td>
<td>ND</td>
<td>NS</td>
<td>1.4*</td>
<td>ND</td>
</tr>
<tr>
<td>Trial 6 (60) – Australia</td>
<td>105 -110</td>
<td>7.9*</td>
<td>4.8*</td>
<td>ND</td>
<td>12.1*</td>
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<tr>
<td>Trial 7 (160) – US</td>
<td>125 -130</td>
<td>8.6*</td>
<td>NS</td>
<td>7.6*</td>
<td>8.1*</td>
</tr>
<tr>
<td>Trial 8 (24) – Brazil</td>
<td>125 -138</td>
<td>9.3*</td>
<td>10.6*</td>
<td>9.3*</td>
<td>ND</td>
</tr>
</tbody>
</table>

*Differ significantly at p<0.05:

NS not significant; ND not determined  # = Feed efficiency last 4 weeks only


### Growth performance & carcass quality (EU data)

- **IC pigs vs. barrows: % improvement**

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<th>Daily Gain (%)</th>
<th>Lean meat (%)</th>
<th>Back or belly fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany (study 1)</td>
<td>NS</td>
<td>9.0*</td>
<td>NS</td>
<td>1.9*</td>
<td>11*</td>
</tr>
<tr>
<td>Germany (study 2)</td>
<td>NS</td>
<td>11.2*</td>
<td>NS</td>
<td>3.4*</td>
<td>16.4*</td>
</tr>
<tr>
<td>Netherlands</td>
<td>NS</td>
<td>9.0*</td>
<td>NS</td>
<td>2.0*</td>
<td>13*</td>
</tr>
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<td>Spain</td>
<td>NS</td>
<td>8.6*</td>
<td>ND</td>
<td>1.8*</td>
<td>15*</td>
</tr>
<tr>
<td>Hungary</td>
<td>NS</td>
<td>ND</td>
<td>9*</td>
<td>ND</td>
<td>18*</td>
</tr>
</tbody>
</table>

* Differ significantly at p<0.05

NS not significant; ND not determined
Safety – For the Pig

- GnRF conjugate for injection includes an aqueous (non-oily) adjuvant and is rapidly cleared from the injection site.
- The formulation is well tolerated. When administered with proper immunization technique, reactions are mild and infrequent.
User Safety

- Use of a safety device is recommended and made available e.g., Secure® Plus by NJ Phillips
- 3 safety mechanisms prevent accidental delivery

- Needle guard
- Unique valves
- Needle guard lock
Safety – For the Consumer

- GnRF Conjugate for injection is a safe and reliable product to stimulate specific antibody production by injection.
- Studies have shown that the GnRF-conjugate antigen has no intrinsic hormonal or pharmacological activity.

The antigen had no effect on the production of luteinizing hormone (LH) when injected into experimental animals.

Source: Clarke, 1996
Natural GnRF binds to pituitary receptors to stimulate LH & FSH release
The GnRF-conjugate antigen

Synthetic analog of GnRF bound to the surface of a large immunogenic carrier protein
Antigen cannot bind to the pituitary receptor and thus has no hormone activity…only immunological
Safety – For the Consumer

- Product has no activity when given orally.
- As expected for a simple protein, studies have shown that it only works when given by injection.
  - Using the pig as a model for human gastric physiology, repeated oral doses of the product showed no physiological effects.
  - Similar studies with both rats and rabbits using repeated and/or intermittent high oral doses (up to 70X) have also shown no effects.
- Where approved (53 countries), all regulatory authorities have approved a 0-day withdrawal time.
Summary

- GnRF Conjugate for Injection is a safe and effective immunological product for the control of boar taint in intact male pigs
- Eliminates the need for physical castration to control boar taint
- Prevents the losses in growth performance, feed efficiency and carcass quality as consequence of physical castration or slaughter of lightweight male pigs
- Provides an alternative to physical castration
- Significant contribution to global sustainability
Thank you for your attention!

Questions?