Selection strategies against boar taint in a Swiss sire line

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Objective

Incorporate selection against boar taint into a breeding program

To do this, we need a reliable and repeatable target trait...

- Boar taint compounds measured in carcasses of half/full sibs or in live selection candidates
- Human nose scores (HNS) in carcasses of half and/or full sibs
Biopsy Information

- Biopsy of neck fat of live selection candidates
- Boar taint compounds (androstenone, skatol and indole) measured in small sample of liquid fat
- $h^2 = 0.30 - 0.60$
- Reproducability $= 0.98$

Baes et al., 2013
Human Nose Score

- Carcass fat samples heated with a hot iron to release the smell normally experienced during cooking
- Score from 0 (no odour) to 4 (strong boar taint) by trained expert panel
- $h^2 = 0.12 - 0.19$
- Reproducability = 0.29

Photo: www.pigprogress.com
Scenarios

1- Current breeding program (on-farm test of male candidates + station testing of sibs)

2- Chemical compounds of boar taint
   a) field biopsy-based performance testing of 1,200 live boars
   b) genomic scenario (GEBVs)
   c) biopsy-based performance testing + genomic scenario

3- Human nose score (HNS)
   a) HNS of 4 full sibs and 76 half sibs (1 or 2 trained persons) on station
   b) genomic scenario (GEBVs)

Haberland et al., submitted
Accuracy of GEBVs

\[ r_\hat{Q} = \sqrt{\frac{N r^2}{N r^2 + M_e}} \]  \hspace{2cm} \text{(Daetwyler et al. 2010)}

\( N \) = Number of animals in reference (1,000)

\( r^2 \) = Reliability of conventional BVs of animals in reference

\( M_e \) = Number of independently segregating QTL

(\( H1,000 \), Goddard et al., 2011)

\( \Rightarrow \) Accuracy is multiplied by \( q=0.9 \) (Dekkers, 2007) and is equal to 0.52 (assumed for both scenarios).
Variable costs

- No selection for boar taint (1)
- Biopsy-based performance testing (2a)
- Genomic info (boar taint components, 2b)
- Combined biopsy-based performance testing + genomic info (2c)
- Station test for HNS (3a)
- Genomic info (HNS, 3b)

Haberland et al., submitted
# Economic weights

<table>
<thead>
<tr>
<th></th>
<th>Percentage of genetic variance of boar taint in the overall breeding goal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>Androstenone</td>
<td>-2.74</td>
</tr>
<tr>
<td>Skatol</td>
<td>-1.69</td>
</tr>
<tr>
<td>Indole</td>
<td>-0.99</td>
</tr>
<tr>
<td>HNS</td>
<td>-2.93</td>
</tr>
</tbody>
</table>

Haberland et al., submitted
Annual gain

No selection for boar taint (1)

Haberland et al., submitted
Annual gain

- No selection for boar taint (1)
- Biopsy-based performance testing (2a)

Haberland et al., submitted
Annual gain

- No selection for boar taint (1)
- Biopsy-based performance testing (2a)
- Genomic scenario (2b)

Haberland et al., submitted
Annual gain

- No selection for boar taint (1)
- Biopsy-based performance testing (2a)
- Genomic scenario (2b)
- Combined biopsy-based performance testing + genomic selection (2c)

Haberland et al., submitted
Annual genetic gain

- Selection against HNS (3a, 1 person)
- Selection against HNS (3a, 2 persons)
- Genomic scenario (3b)
- Biopsy-based performance testing (2a)

Annual genetic gain in units of the trait

Haberland et al., submitted
Expected Trend: Androstenone

µg/g liquid fat

years

No selection for boar taint

Biopsy-based performance testing (5%)

(10%)

(20%)

Haberland et al., submitted
Summary & Outlook

- Need cost-effective, repeatable trait for early identification of low-risk boars
- Average boar taint compound levels (and therefore also HNSs) decline without direct selection
- Average boar taint compound levels can be reduced more quickly by selecting against boar taint
- Biopsy-based performance testing most efficient

Further research

- Long term effects? Fertility? (Strathe et al.)
- How to process tainted carcasses?

The authors gratefully acknowledge funding by the SUISAG and the Swiss Commission for Technology and Innovation (KTI)
Selected production traits

<table>
<thead>
<tr>
<th>Production trait</th>
<th>Monetary genetic gain (Euro)</th>
</tr>
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<tbody>
<tr>
<td>LMP</td>
<td>1.40</td>
</tr>
<tr>
<td>SUR</td>
<td>1.20</td>
</tr>
<tr>
<td>FCR</td>
<td>1.00</td>
</tr>
<tr>
<td>ADG_S</td>
<td>0.80</td>
</tr>
<tr>
<td>DL</td>
<td>0.60</td>
</tr>
<tr>
<td>IMF</td>
<td>0.40</td>
</tr>
</tbody>
</table>

- **LMP**: lean meat percentage
- **SUR**: surface area
- **FCR**: feed conversion ratio
- **ADG_S**: average daily gain (on station)
- **DL**: drip loss
- **IMF**: intramuscular fat

Haberland et al., submitted

- **No selection for boar taint**
- **Biopsy-based performance testing (2a, 5%)**
- **(2a, 10%)**
- **(2a, 20%)**
<table>
<thead>
<tr>
<th>Trait</th>
<th>$h^2$</th>
<th>$\sigma_P$</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily gain (ADG, station test)</td>
<td>0.27</td>
<td>85.33</td>
<td>g/day</td>
</tr>
<tr>
<td>Feed conversion ratio (FCR)</td>
<td>0.35</td>
<td>0.16</td>
<td>kg/kg</td>
</tr>
<tr>
<td>Intra-muscular fat (IMF)</td>
<td>0.60</td>
<td>0.53</td>
<td>%</td>
</tr>
<tr>
<td>Drip loss (DL)</td>
<td>0.30</td>
<td>1.71</td>
<td>%</td>
</tr>
<tr>
<td>Lean meat percentage (LMP)</td>
<td>0.34</td>
<td>2.45</td>
<td>%</td>
</tr>
<tr>
<td>Androstenone (AND)</td>
<td>0.45</td>
<td>0.90</td>
<td>ln(µg/g)</td>
</tr>
<tr>
<td>Skatole (SKA)</td>
<td>0.49</td>
<td>0.53</td>
<td>ln(µg/g)</td>
</tr>
<tr>
<td>Indole (IND)</td>
<td>0.55</td>
<td>0.34</td>
<td>ln(µg/g)</td>
</tr>
<tr>
<td>Human nose score (HNS)</td>
<td>0.12</td>
<td>0.95</td>
<td>score</td>
</tr>
</tbody>
</table>
Sire Line

Dam Lines

Nucleus

Multiplication

Production

Bern University of Applied Sciences
School of Agricultural, Forest and Food Sciences
SUISAG: Service center for pork production
<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>AKP</td>
<td>CB_SH</td>
<td>HW_G</td>
<td>MW_G</td>
<td>GewH</td>
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<tr>
<td>Amtliche Kochprobe (AKP)</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
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<tr>
<td>CB_Schachthaus (CB_SH)</td>
<td>0.36</td>
<td>1.00</td>
<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
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<tr>
<td>HW_Gesamt (HW_G)</td>
<td>0.24</td>
<td>0.18</td>
<td>1.00</td>
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<td>0.00</td>
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<tr>
<td>HW_Androstenon (HW_A)</td>
<td>0.25</td>
<td>0.19</td>
<td>0.79</td>
<td>1.00</td>
<td>0.00</td>
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<tr>
<td>HW_Skatol (HW_S)</td>
<td>0.14</td>
<td>0.07</td>
<td>0.79</td>
<td>0.42</td>
<td>0.00</td>
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<tr>
<td>HW_Indol (HW_I)</td>
<td>0.20</td>
<td>0.12</td>
<td>0.76</td>
<td>0.35</td>
<td>0.27</td>
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<tr>
<td>MW_Gesamt (MW_G)</td>
<td>0.27</td>
<td>0.22</td>
<td>0.34</td>
<td>0.30</td>
<td>0.22</td>
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<td>0.24</td>
<td>0.24</td>
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<tr>
<td>MW_Skatol (MW_S)</td>
<td>0.18</td>
<td>0.17</td>
<td>0.22</td>
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<td>0.17</td>
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<tr>
<td>MW_Indol (MW_I)</td>
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<td>0.21</td>
<td>0.24</td>
<td>0.21</td>
<td>0.24</td>
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<tr>
<td>HodenGewicht (Gew_H)</td>
<td>0.12</td>
<td>0.21</td>
<td>0.22</td>
<td>0.24</td>
<td>0.17</td>
</tr>
<tr>
<td>Androstenon (And)</td>
<td>0.22</td>
<td>0.31</td>
<td>0.39</td>
<td>0.45</td>
<td>0.42</td>
</tr>
<tr>
<td>Skatol (SKa)</td>
<td>0.15</td>
<td>0.02</td>
<td>0.26</td>
<td>0.06</td>
<td>0.14</td>
</tr>
<tr>
<td>Indol (Ind)</td>
<td>0.10</td>
<td>0.03</td>
<td>0.22</td>
<td>0.06</td>
<td>0.14</td>
</tr>
<tr>
<td>LNAndrostenon (LNAEnd)</td>
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<td>0.10</td>
<td>0.31</td>
<td>0.33</td>
<td>0.17</td>
</tr>
<tr>
<td>LNSkatol (LNSK)</td>
<td>0.15</td>
<td>0.07</td>
<td>0.18</td>
<td>0.17</td>
<td>0.17</td>
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<tr>
<td>LNIndol (LNInd)</td>
<td>0.09</td>
<td>0.10</td>
<td>0.17</td>
<td>0.16</td>
<td>0.11</td>
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<tr>
<td>CoMore</td>
<td>-0.14</td>
<td>0.04</td>
<td>0.14</td>
<td>0.00</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

(Pearson Korrelationen)

- r = 0 : |0.10|
- r = 0.11 : |0.19|
- r = 0.2 : |0.5|
- r = 0.51 : |0.79|
- r = 0.8 : |1.0|

(r < 0.05)

- NS
Number of animals which could be excluded from a sensoric test using testes weight as a boar taint indicator

Indirect traits for boar taint?
- Testes weight alone explained 17.5% of the variance in androstenone
- Other autoFOM values...? (shoulder size, etc.?)

Estimate testes size (weight) automatically?

![Graph showing the relationship between testes weight and androstenone](image-url)
The Biopsy Device

Geverink et al (1999) described behavioural and physiological responses of pigs (n=10, 23 weeks of age) biopsied (muscle tissue):
- 70% of the pigs vocalized when the biopsy was taken
- all pigs flinched in response to the biopsy in that study.

In contrast, animals in our study showed very little pain response when biopsied.
- slightly thinner needle which minimized the invasiveness of sampling
- strength of the compression spring
- biopsy of fat and not muscle (less pain, less bleeding)

Irie and Sakimoto (1992) adjusted the length of the biopsy needle to the thickness of the back fat based on ultrasonic measurements to avoid reaching muscle tissue. This measure was not taken in our study for practical reasons. Instead, the biopsy device was held at a 35° angle to the body of the pig to ensure maximal fat and minimal muscle sampling.
Selection Index

The number of traits in the breeding goal must be chosen carefully, because increasing the number of traits decreases the amount of genetic progress per trait. With regards to boar taint, reducing the off-odour (HNS) of heated pork is the objective. Estimated breeding values (EBVs) for androstenone, skatole, indole or other compounds can be weighted accordingly to model individual contributions to the aggregate breeding objective (in this case, HNS). A method such as that presented by Schneeberger et al. (1992) could be used to calculate appropriate weights for EBVs. Using this method, weights depend only on genetic variances and covariances among the individual boar taint components and the HNS, and on the economic values of these traits.