SABRE CUTTING EDGE GENOMICS FOR SUSTAINABLE ANIMAL BREEDING

Genetics and aggressive behaviour, welfare and product quality issues

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Background- pig aggression

- Aggression between pigs occurs when unfamiliar pigs are mixed
  - On farm
  - For slaughter- mixed onto truck, and on arrival at slaughter house (lairage)
- Aggression affects pig welfare:
  - Social stress
  - Biting leads to skin lesions
- Aggression affects product quality:
  - Carcass yield because of skin lesions
  - Physiological changes as a result of stress, which impact on meat quality

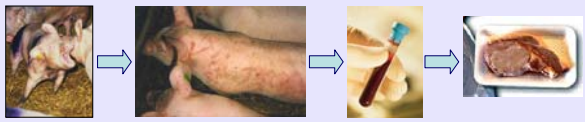
Aggressive temperament in pigs

- Pigs show individual differences in their propensity to be aggressive ("aggressiveness")

- Aggressiveness is partly under genetic control (h^2 = 0.38, 0.43; Turner et al. 2008 and in prep)

Aggressive temperament in pigs

1. To better understand the relationship between aggression, stress and meat quality
   - At the phenotypic level
   - By studying gene expression in tissues relating to stress (adrenal gland) and meat quality (loin muscle)
2. To investigate the effect of aggressiveness on aggression, stress and meat quality



Experiment in three parts

560 ♂ and ♀ pigs in 8 batches of ~70

1. Aggressiveness
2. Pre-transport mixing
3. Slaughter

1. Aggressiveness

At ~10 weeks old, mix pigs into groups of balanced composition (2+2+2+2=8)

Count skin lesions (change pre-post mixing) and classify pigs as High (H) or Low (L) aggressiveness

2. Pre-transport mixing

~27 weeks old, count skin lesions (pre-mixing)

8 batches:

- 4 **'controlled mixing'** batches: Mixed onto truck on the basis of aggressiveness (4+4 = 8)
  - High + High (HH)
  - High + Low (HL)
  - Low + Low (LL)
  - Unmixed (U) onto truck
  - No mixing at lairage

- 4 **'uncontrolled mixing'** batches: commercial-style mixing at transport and again at lairage

3. Slaughter

- Carcass skin lesion count
- Blood sample for stress measures:
  - Cortisol
  - Creatine Kinase (CK)
  - Glucose
  - Lactate
- Meat quality measures
  (Loin muscle, *M. longissimus dorsi*)
  - pH at 3,6 and 24 hrs
  - Drip loss (to 48hr)
  - Colour (light-, red-, and yellow-ness)

Results

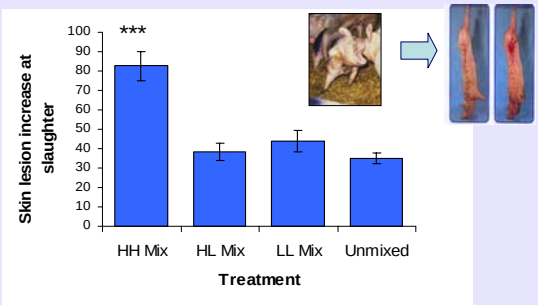
- Controlled mixing batches
- Uncontrolled mixing batches

Results

- **Controlled mixing batches**
- Uncontrolled mixing batches

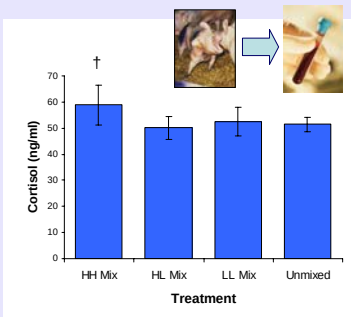
Results- controlled mixing

- **Skin lesions** increase at slaughter more in HH groups (F=11.73, p<0.001)



Results- controlled mixing

- **Cortisol** tends to be higher in HH pigs (F=2.49, p=0.061)



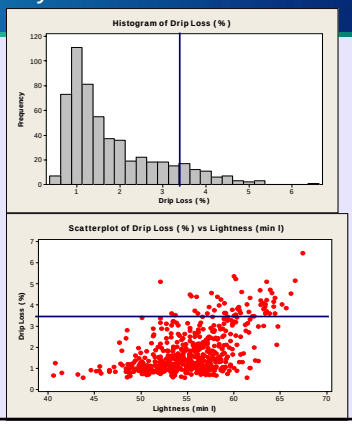
- Skin lesions associated with higher cortisol
  (front lesions, r^2=7.7, F=6.64, p=0.019)

No difference in:

- Creatine Kinase
- Glucose
- Lactate

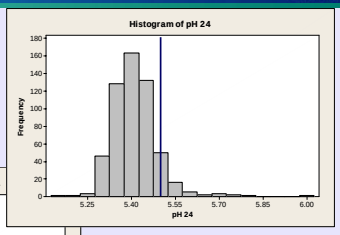
Poor meat quality- PSE meat

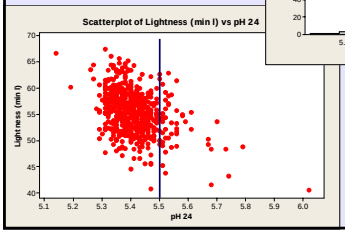
- Pale soft exudative (PSE)
  - High drip loss
  - pale colour
- Threshold of >3.5%



Poor meat quality- DFD meat

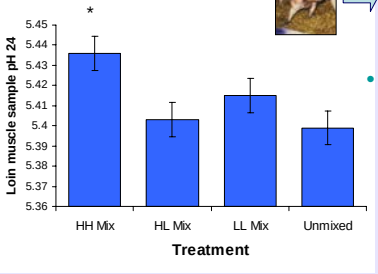
- Dry firm dark (DFD)
  - High pH after 24hrs
  - Dark colour





Results- controlled mixing

- Loin muscle **pH at 24hrs** higher in HH groups (r^2=5.4%, F=3.79, p=0.011)



- Higher skin lesions also associated with higher pH 24 (r^2=5.1%, F=8.38, p=0.004)

Results- controlled mixing

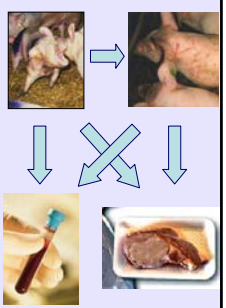
- DFD meat- more HH pigs have loin muscle pH 24 > 5.5:

Trt	Under	Over	(% Over)
HH	**52**	**11**	**17.5%**
HL	60	2	3.2%
LL	58	7	10.8%
U	61	4	6.2%

(χ_3^2=8.52; p=0.036)

Conclusions- controlled mixing

- Mixing pigs of high aggressiveness (assessed at 10 weeks of age):
  - increased aggression pre-slaughter
  - increased stress (cortisol)
  - reduced meat quality (DFD meat)
  - Skin lesions associated with stress and meat quality



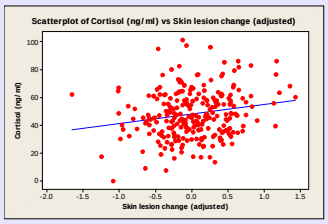
Results

- Controlled mixing batches
- **Uncontrolled mixing batches**

Results- uncontrolled mixing

Skin lesions are positively associated with:

- **Cortisol** (r^2=12.5%, F=8.47, p=0.004)
- Lactate (r^2=23.3%, F=3.13, p=0.078)



- No association between **skin lesions** and meat **quality**

Results- Uncontrolled mixing

Stress and meat quality

DFD

- High cortisol associated with
  - darker meat (lightness, r^2=18.0%, F=6.50, p=0.011)
  - higher pH 24 (r^2=17.1%, F=3.17, p=0.076)
- High Creatine Kinase associated with
  - higher pH24 (r^2=21.0%, F=15.23, p<0.001)
  - Pigs with ph24 > 5.5 have higher CrK (r^2=6.3%, F=3.97, p=0.048)

PSE

- High lactate
  - lower pH 3 (r^2=21.0%, F=14.79, p<0.001)
  - Pigs with drip loss >3.5% have higher lactate (r^2=25.4%, F=8.14, p=0.005)

Conclusions- unstructured mixes

Lesion change at slaughter → 12.5% → Cortisol

Conclusions- unstructured mixes

Cortisol → 18% → DFD- darker meat with higher pH 24

Conclusions- unstructured mixes

Lesion change at slaughter → 13% → Cortisol → 18% → DFD- darker meat with higher pH 24

Lesion change at slaughter → 2.3% → DFD- darker meat with higher pH 24

Conclusions- unstructured mixes

Lesion change at slaughter → 13% → Cortisol → 18% → DFD- darker meat with higher pH 24

Lesion change at slaughter → 2.3% → DFD- darker meat with higher pH 24

Lesion change at slaughter → 23% → Lactate → 25% → PSE- low initial pH, drip loss >3.5%

Lesion change at slaughter → 5.8% → PSE- low initial pH, drip loss >3.5%

Discussion- aggression, stress and meat quality

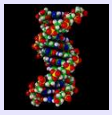
- Various pre-slaughter stressors affect meat quality- transport handling, noise etc.
- Aggression also important, particularly for DFD meat (Warris & Brown 1985; Terlouw et al. 2005)
  - DFD is caused by prolonged activity pre-slaughter depleting muscle glycogen stores
  - Elevated cortisol is an indicator of this prolonged stress
  - PSE is caused by acute stress closer to slaughter
- Aggression could be reduced by:
  - Avoiding mixing pre-slaughter
  - Genetic selection for less aggressive temperament

Discussion- controlled vs. uncontrolled mixing

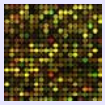
- Aggression affected stress and meat quality in our small controlled experiment.
- In the uncontrolled 'commercial style' mixing, the effect of aggression on meat quality was too small to be statistically significant, but small effects may be important across the whole pig population

Discussion- genetic aspects

- We know there are genetic influences on all the traits of interest here:
  - Aggressiveness (Turner et al. 2008 and in prep)
  - Stress reactivity (Mormède et al. 2002)
  - Meat quality (Plastow et al. 2005)



- Ongoing gene expression studies (microarray) will help us understand more about how they are inter-related



SABRE WP 8, task 8.2.2 collaborators

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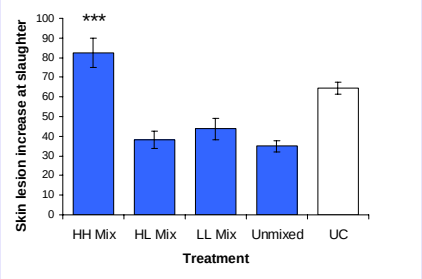
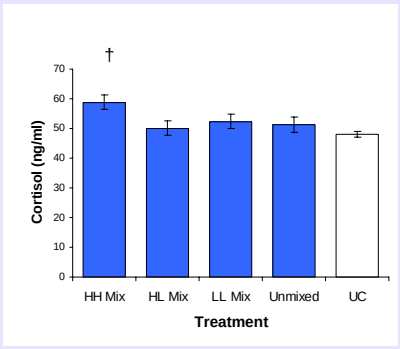
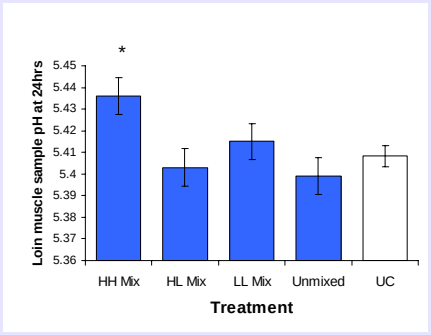
- Gary Evans (Genus, UK); Ludger Thölking, Holger Looft, Esra Kurt (Genus (PIC), Germany)
- Klaus Wimmers, Eduard Murani (FBN Dummerstorf, Germany)
- Aline Foury, Pierre Mormède (INRA, France)
- Ronald Klont (Ex PIC, now Vion Foods, Netherlands)
- Many thanks to Peter Andresen (Pig farmer)

SAC







Results- controlled mixing

- PSE meat- no treatment difference in:
  - Drip loss (%)
  - Pigs over 3.5% threshold:

Trt	Under	Over	% Over
• HH	57	6	9.5%
• HL	55	7	11.3%
• LL	58	7	10.8%
• U	59	6	9.2%

(χ_3^2=0.20; p=0.977)