

Genetics and genomics of boar taint – ongoing research in Norway

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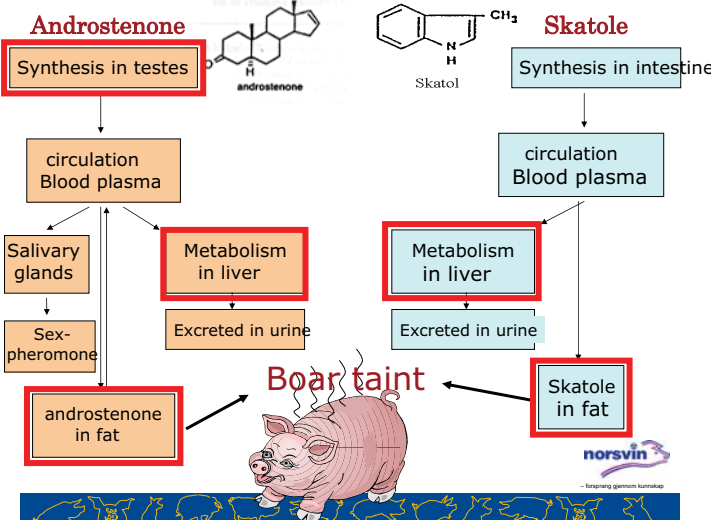


Boar taint - Background

- Boar taint is due to an excessive accumulation of androstenone and skatole in adipose tissue in uncastrated male pigs
- Castration will be banned in Norway
- Without castration a large amount of the animals will be dismissed:

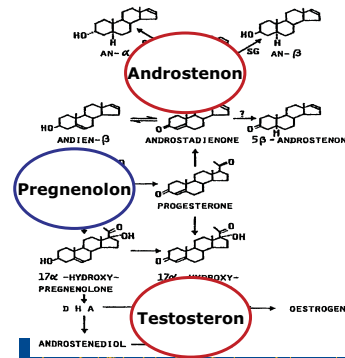
Breed	Androstenone	Skatole
Duroc	83% > 1 ppm	9.5% > 0.2 ppm
Landrace	34% > 1 ppm	14.5% > 0.2 ppm

(From boars in boar testing stations (n=3300))



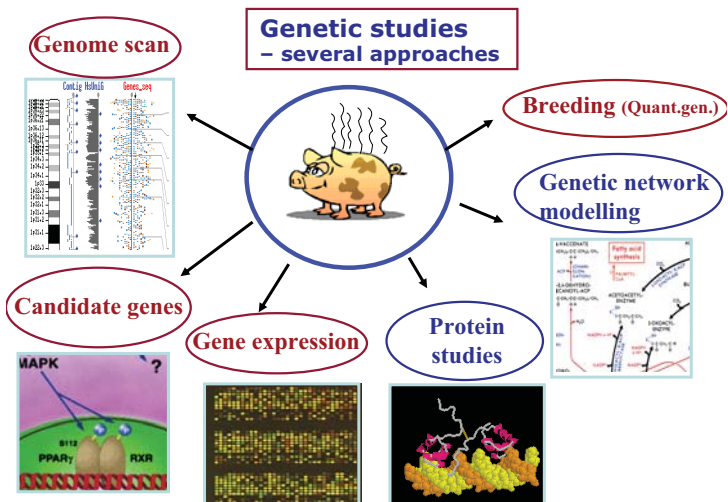
Goal

Identify genetic factors affecting the boar taint compounds androstenone and skatole, and study relationships between genes.



The goal is to:

- ↓ androstenone
- ↓ skatole
- = fertility traits
- = production traits



Animal Material

~1800 Norwegian Landrace
 ~1200 Duroc
 + parents

From Norsvin's boar testing stations

Phenotypic records:

- Androstenone (blood and fat)
- Skatole and indole (fat)
- Testosterone
- Oestrone sulphate, Oestradiol
- Glandula bulbo urethralis (length)
- Production traits (growth, feed consumption, backfat traits, health, etc.)

As a measure of sexual maturity

Tissue samples

Testicle, liver, fat

Correlations and heritabilities for skatole, androstenone and other sex steroids:

Trait	ln(andro_p)	ln(andro_f)	ln(skatole)	ln(indole)	ln(testo)	ln(estradiol)	ln(estron)
ln(andro_plasm)	0.56						
ln(andro_fat)	0.67						
ln(skatole)	0.44 (0.15)						
ln(indole)	0.38 (0.17)	0.37					
ln(testosterone)	0.90 (0.07)	0.80	0.27				
ln(estradiol)	0.89 (0.04)	0.83	0.32	0.16			
ln(estronsulphate)	0.92 (0.04)	0.83	0.64	0.17	0.93 (0.05)		
		0.92	0.83			0.65	



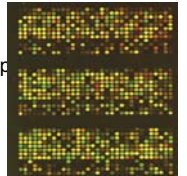
Gene expression

The gene expression level in testis and liver – comparing extreme groups of high/low androstenone levels

Landrace (n=60): High – 5.91 ppm, Low – 0.15 ppm
 Duroc (n=60): High – 10.27 ppm, Low – 0.42 ppm

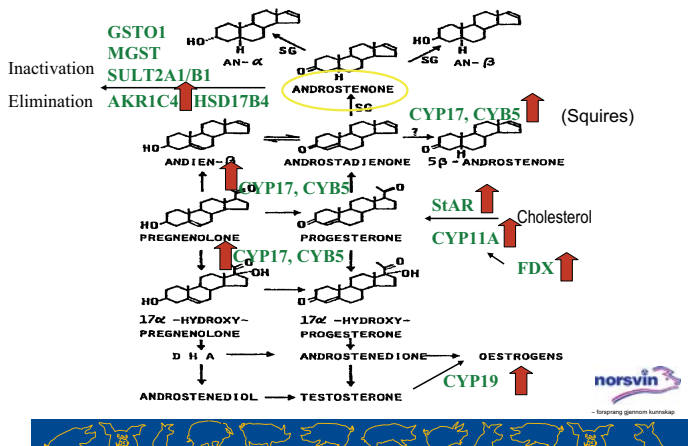
1. Microarray ⇒ Simult. expression of transcr. (array, ~ 27K cDNA clones, Foulum, Bendixen's group)

2. QPCR ⇒ Confirmation of gene expression



Testes

Results - Gene expression



Liver

Results - Gene expression

Phase I oxidation genes:

CYP2E1 ↓ DH and NLH
 CYP2A19 (CYP2A6) ↓ DH

Previously associated with skatole metabolism (Squires et al.), not androstenone

Phase II conjugation genes (increases polarity and facilitates excretion):

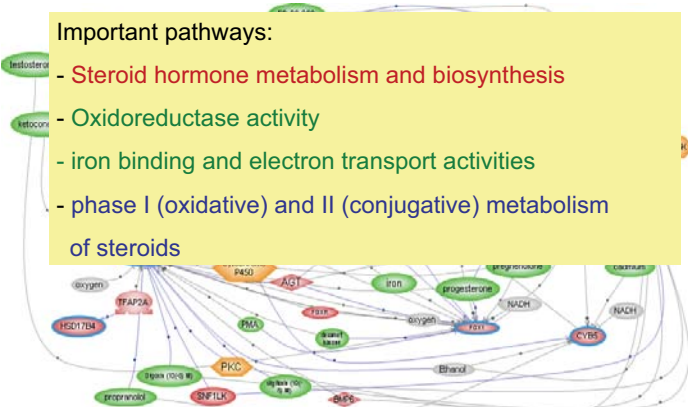
SULT2E1 (estrogen sulfotransferase) ↑ ↓
 UGT1A5 and UGT2B15 (UDP-glucuronosyltransferases) ↑ ↑
 NAT12 (fam. N-acetyltransferases) ↑ ↑



Gene Ontology – to find relationship between sign. genes, biochemical pathways up/down-regulated, biological processes involved, etc.

Important pathways:

- Steroid hormone metabolism and biosynthesis
- Oxidoreductase activity
- iron binding and electron transport activities
- phase I (oxidative) and II (conjugative) metabolism of steroids



Candidate gene approach

Investigation of candidate genes based on literature, and genes detected from gene expression studies

Two step strategy:

- 380 Norwegian Landrace and 380 Duroc boars: 277 SNPs in 123 candidate genes
- 1726 Norwegian Landrace and 1102 Duroc boars: 137 SNPs in 60 candidate genes

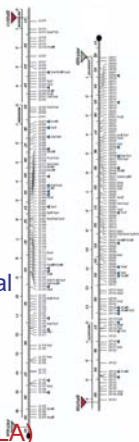
Statistical analyses: Likelihood ratio test (LRT), p<0.001 (5,4), DMU (pack)

→ To be published



Genome scan

SNP-markers



- To detect QTLs affecting boar taint, compounds related to fertility and production traits

→ 2900 animals + parents (Duroc + Landrace)

→ 7400 SNPs (Illumina):

- Duroc: 3566 SNPs
- Landrace: 3116 SNPs } 4232 SNPs in total

- Genetic maps constructed



Linkage disequilibrium/Linkage analysis (LD/LA)



Summary

"New" and "old" candidate genes related to levels of androstenone were identified by gene expression studies, and the gene ontology revealed the pathways involved.

Breed specific differences are suggested - in gene expression, protein expression and SNP association.

Some SNPs were highly associated with the levels of androstenone and skatole, and some were not simultaneously associated with the other sex compounds.

Confirmation of results are needed.



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Collaborators:

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Prof. Olena Doran, England (protein expression, cell studies)
Veterinary School (Øystein Andresen's group) (anal. andro/skatol)
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