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Rearing non-castrated male pigs in organic farming and avoiding boar taint in pork

Bénédicte Lebret and Armelle Prunier - INRAE

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INRAE

National Research Institute for Agriculture, Food and Environment

= INRA (National Institute for Agricultural Research)
+ IRSTEA (National Research Institute of Science and Technology for the Environment and Agriculture.

Research that serves society

• produce and disseminate knowledge to help solve major societal challenges
• put this knowledge to work to foster innovation, provide expertise, and lend support to public policies

• ≈ 8000 permanent staff + 4000 non-permanent
• 14 scientific divisions
• 202 research units and 43 experimental units

Context

Organic farming

- EU regulation (2018/848 and 2020/464) in force in 2022
- Endorsed by European policy: Farm to fork strategy for a fair, healthy and environmentally friendly food system (EU, 2020)
- Organic food chosen by consumers for health, food quality, and ethical motives: environmental consciousness and animal welfare

Baudry et al., 2017; AgenceBio, 2022

Context

Male pigs farming - organic and conventional systems

- Ban of surgical castration of male pigs without anesthesia in France from January 2022 (same situation in other EU countries)

- Only surgical castration with anesthesia (local or general) and analgesia is allowed, but :

  - more complicated, time-consuming and costly operation
  - does not completely avoids pain during and after castration
  - the wound can be source for infection
  - Still a mutilation for the pigs!

Prunier et al., 2020

Main advantages and disadvantages to stop castration of male pigs

Synthesis from scientific knowledge on conventional farms:

No more surgical intervention

→ positive for the farmer (work) and animal welfare

Better feed conversion

→ reduces feed costs and environmental impacts (nitrogen)

Risk of harmful behaviour (mounts and aggressivity)

→ farm management has to be adapted

Higher carcass leanness (Lean Meat Percentage)

→ higher commercial value

Risk of 'boar taint': undesirable odour and/or flavour

→ carcasses have to be identified and meat used accordingly

Lundström et al., 2009; Prunier et al., 2013; Parois et al., 2018; von Borell et al., 2020

Boar taint: what is this?

Boar taint is mainly due to two molecules

	Androstenone	Skatole
Synthesis	Testes (Leydig cells)	Gut (bacteria)
Direct elimination	Saliva	Faeces
Storage	Fat tissue	Fat tissue
Degradation	Liver and kidneys	Liver and kidneys
Elimination after degradation	urine	urine

(Zamaratskaia et Squires, 2009; Wesoly & Weiler, 2012; Robic et al., 2014; Meinert et al., 2017)

- Almost all consumers are sensitive to skatole *(MeierDinkel et al., 2013)*
- Some people are not or little sensitive to androstenone *(Font-i-Furnols, 2012)*

➢ Products from boar-tainted meat have +/- risks to be rejected by consumers

(Bonneau, 1998; Bee et al., 2015; Parois et al., 2018)

➢ Boar-tainted carcasses have to be identified on the slaughter chain

How to use boar tainted carcasses ?

According to their use, pork and products issued from tainted carcasses have more or less risks to be rejected by consumers

- **Higher risks are for :**
  - Fresh pork cooked at home, especially for fat pork
  - Fat pork products cooked at home (grilled) and consumed hot: bacon, sausages

➢ Requires **screening and sorting of the carcasses on the slaughter line** to optimise their use:

- For fresh meat or processed products (-> consumed cold)
- With or without "masking" techniques: smoking, spices
- With or without "dilution" with non-tainted meat

(Lebret, 2020)

How to detect boar taint at slaughterhouse?

In France (and other countries) : the Human Nose evaluation

- Method implemented by UNIPORC (independent chain actor for carcass classification) with the help of IFIP-Technical Institute for Pig production

- Panelists are selected on their ability to detect and identify boar taint odors, are trained to scoring, and their aptitudes regularly controlled

2 steps :

- Heat the backfat around the neck
- Smell and note : score from 1 to 5 *(score : from 0 to 2 by Cooperl company)*

Avantages of the method

- Easy to implement
- Immediate result
- Good detection of highly tainted carcasses
- Cheap

Limits of the method

- Subjectivity despite training of the operators
- Some boar-tainted carcasses might not be identified

How to detect boar taint ? Other methods

In laboratory

Determination of androstenone and skatole contents in backfat by HPLC (High performance liquid chromatography): « reference » method

- Takes time (esp. because needs first a step of extraction of the molecules from the fat) and skilled lab technicians to perform the analyses
- Not possible to use online (slaughterhouse environment) for the sorting of carcasses
- Androstenone and skatole contents are associated to a risk for boar taint according to threshold values

Extensive research has been conducted since years/decades to develop rapid online methods to identify tainted carcasses!

Implementation of on-line method in Denmark

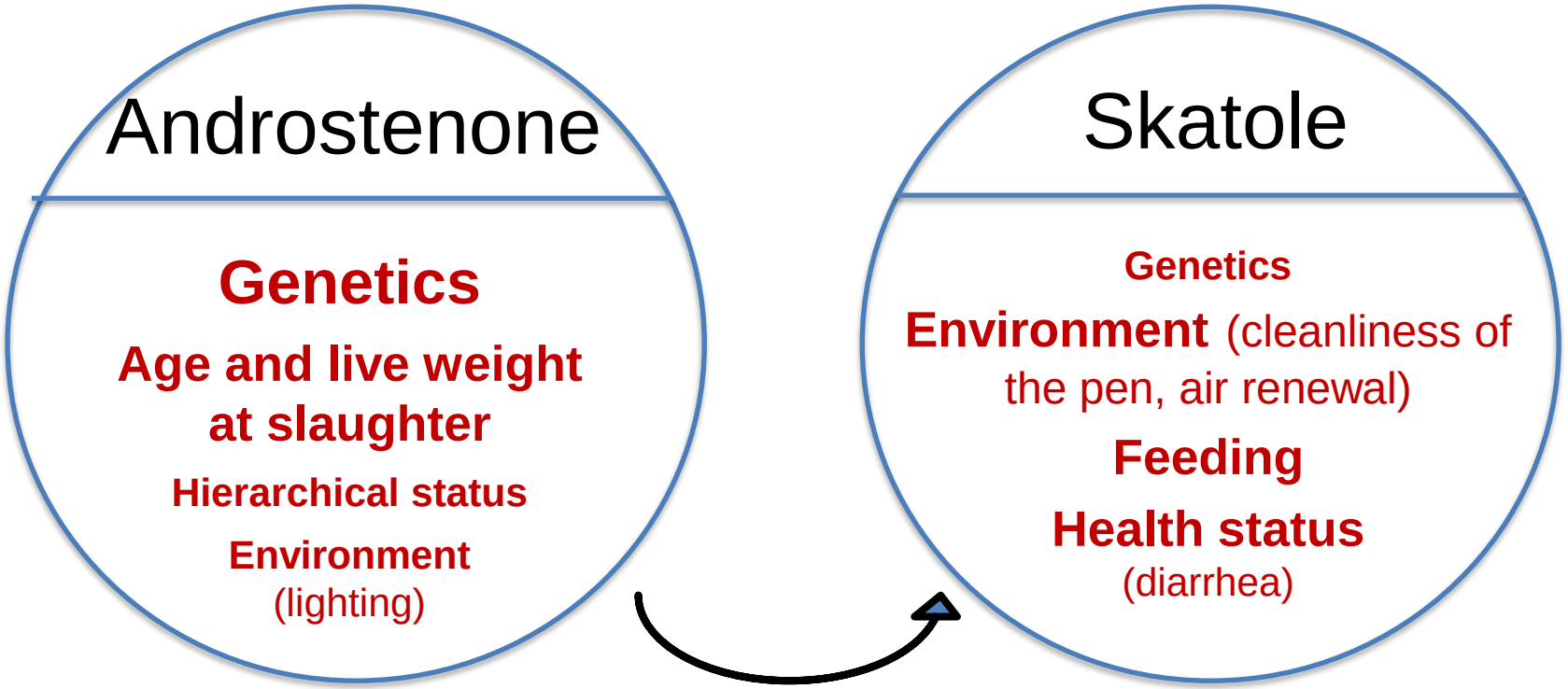
Development and implementation of a mass spectrometry method with automated sampling and sample pretreatment

- Fast, robust and measures both androstenone and skatole levels
- … expensive!

(Borggaard et al., 2017)

How to control boar taint ?

Risk factors and levers at farming level



(Parois et al., 2018; Aluwé et al., 2020)

Rearing of male pigs in organic farming

- Better to avoid surgical castration to guarantee high welfare standard,
  BUT: develop strategies to **prevent undesired behaviors** (mounting, aggressions) in intact males and **avoid boar taint** in meat and pork products

- Allow ending of surgical castration in good conditions for animals, farmers, consumers

PPILOW
Poultry and Pig Low-input and Organic production systems' Welfare

→ various strategies have been tested, aiming at reducing or controlling the risk for boar taint of organic intact male pigs, due to:

- Androstenone -> effects of **pig genotype and slaughter weight: study 1**, **INRAE**
- Skatole: effects of **feeding and animal management: study 2, IFIP** study

Effects of pig genotype and slaughter weight on animal welfare indicators and meat quality

Study 1 INRAE

- **Health and welfare indicators, boar taint, carcass and meat quality from intact male pigs in 2 genotypes: Duroc (x Large White) vs Piétrain (x Large White)**

  - Breed differences in animal behavior -> also for intact males in organic farming? *Terlouw et al., 2009;*

  - Piétrain: “standard”, used in conventional & organic, low risk for boar taint

  - Duroc: improved meat eating and technological quality, but higher risk for boar taint *Lebret & Candek-Potokar, 2022; Lebret et al., 2023*

- **Prediction of boar taint risk at lower slaughter live weight**

Experimental design

INRAE Porganic experimental facilities

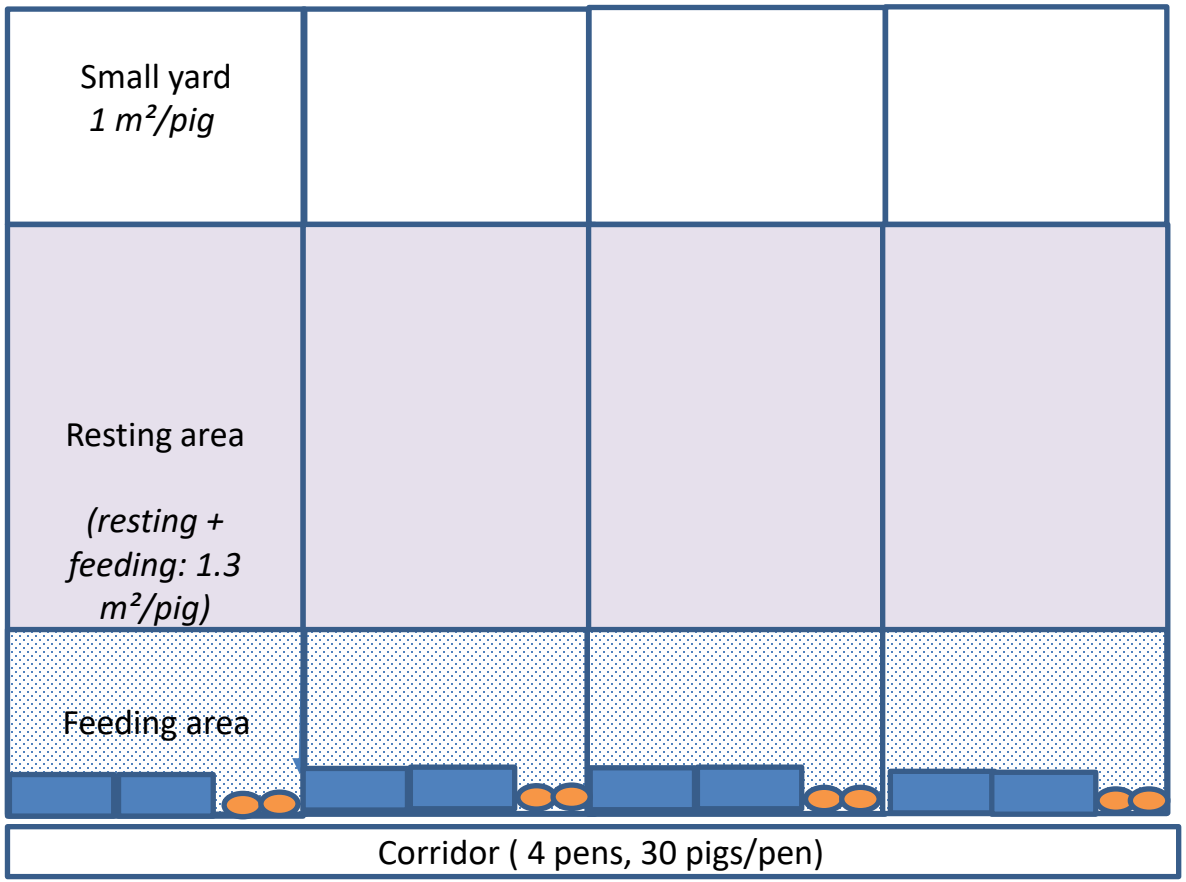
Partners: IFIP (health & welfare), Nucleus (genetic selection), Cooperl (slaughterhouse)

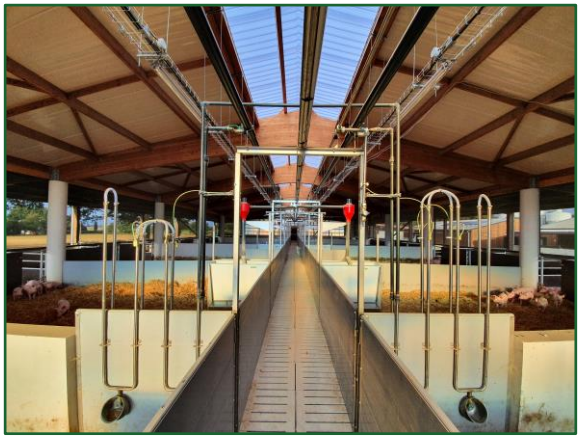
- ✓ *2 experimental replicates, each including one group of intact males per genotype*

  => 47 DuxLW and 34 PixLW in total
- ✓ *Feeding: growing and finishing organic diets (ad libitum) and hay in a rack*
- ✓ *2 slaughtering sessions per replicate, with similar number of pigs from each genotype*

- ✓ *Observations of health and welfare during rearing*
- ✓ *Blood sampling during fattening (2 to 4 samples/pig)*
- ✓ *Growth performance and carcass traits*
- ✓ *Meat quality traits and boar taint components*

Porganic experimental facilities





2 pens filled every 6 weeks

1 pen Pietrain x LW, 1 pen Duroc x LW

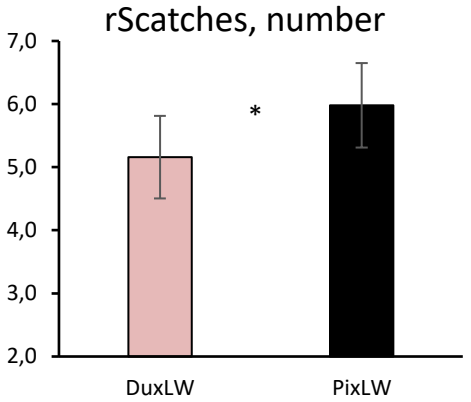
Results

Indicators of health and welfare

On-farm indicators (% of pigs - average of 3 observations)	Duroc x LW	Pietrain x LW	Sign.
Mortality rate	0	5.7	ns
Pigs with skin wounds ≥ 5 cm	1.3	3.0	ns
Pigs with ≥ 15 scratches on one side	0	24	**
Pigs with tail lesions	3	5	ns
at end of finishing	0	9	t

**: P<0.01, * : P<0.05; t: P<0.10)

- *Lower proportion of pigs with skin scratches for Duroc vs Pietrain crossbred males*
- *↘ aggressive or mounting behaviors*
- *Some indicators of degraded health are higher (but NS) for Pietrain crossbreeds*
- ***Improvement of welfare indicators in intact males of Duroc vs Pietrain genotype***



Carcass scratches at slaughterhouse
(square root values)

Growth performance and carcass traits

	Duroc x LW	Pietrain x LW	Significance
Number of pigs	47	34	
Final live weight, kg	124.2	125.4	ns
Average growth rate (27-125 kg), g/d	952	966	ns
Average daily feed intake, kg	2.73	2.80	-
Feed conversion ratio	2.85	2.88	-
Carcass dressing, %	76.1	76.8	G*, R**
Hot carcass weight, kg	96.5	98.4	G*
Lean meat content, %	58.9	60.8	G***

effects of genotype: G and replicate: R; ***: P<0.001, **: P<0.01 *: P<0.05), ns : P>0.05

- ***Similar growth performance*** *in Duroc and Pietrain crossbreeds*
- ***Lower carcass weight and lean meat content*** *in Duroc pigs*
  (higher fat and lower muscle thickness)

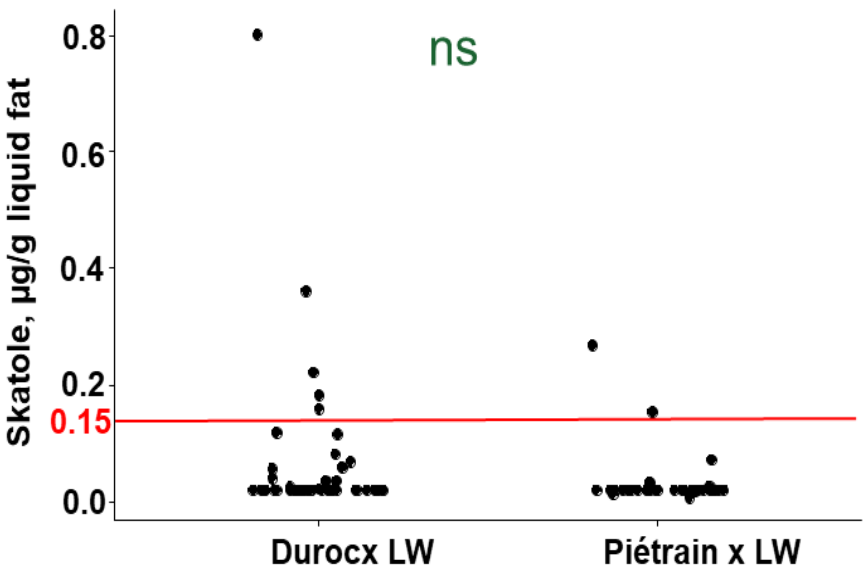
Meat quality traits of the loin (longissimus)

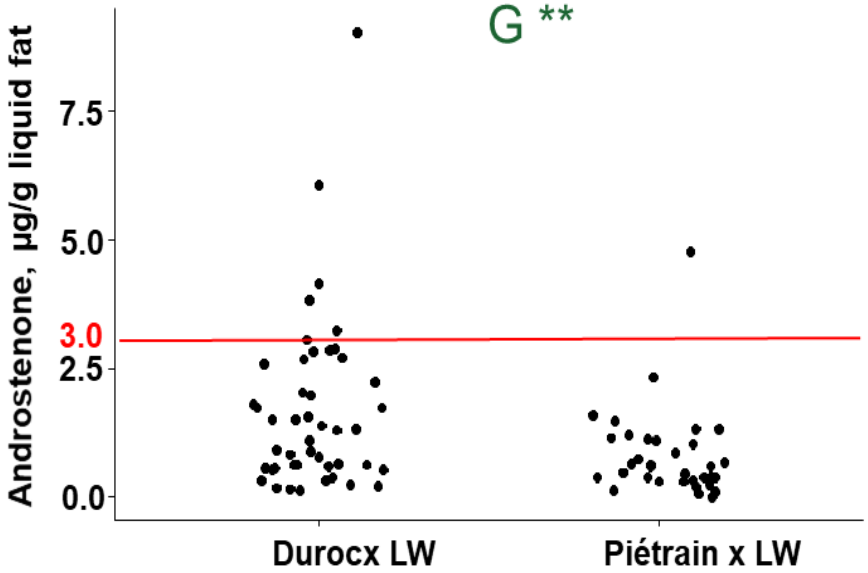
	Duroc x LW	Pietrain x LW	Sign.
pH 24 h	5.51	5.50	
Drip loss,%	4.70	5.66	G*
Colour: lightness (L*)	48.9	50.0	G*
Colour: redness (a*)	7.45	6.97	G*
Intramuscular fat content, %	2.50	1.90	G***
Shear force of cooked meat, N	33.2	35.0	G^t

(effects of genotype G and replicate R, ***: P<0.001, *: P<0.05, t: P<0.10)

- *Similar ultimate pH (also in ham muscles)*
- *Overall: higher water-holding capacity, redness and IMF, lower lightness and toughness of pork in* ***Duroc pigs => higher technological and sensory quality traits***

Boar taint components in backfat

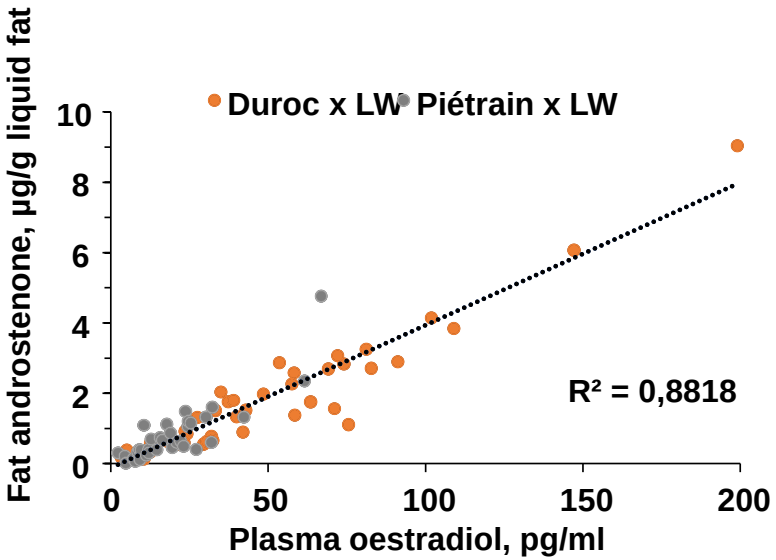


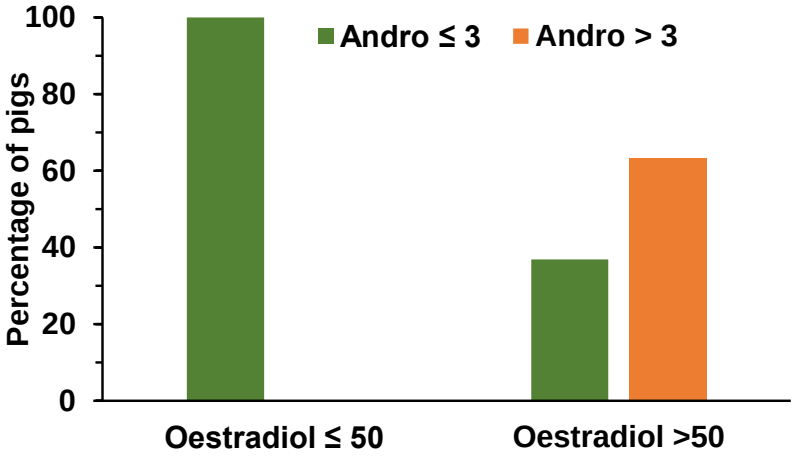


- *Similar average skatole, but higher androstenone content in Du. vs Pi. crossbreeds*
- *Only 1 Duroc carcass detected as odorant at slaughterhouse (highest skatole)*

- *Considering **limits of "perception"** (rejection) by consumers to be **0.15 µg/g** for skatole and **3.0 µg/g** for androstenone, **more carcasses from Duroc (17.4%) than Pietrain (8.8%) crossbreeds would be rejected***

Plasma oestradiol and relationships with androstenone in backfat





- *Higher plasma oestradiol for Duroc vs Pietrain pigs*
- *Very high correlation between plasma oestradiol and fat androstenone*
  => plasma oestradiol can be used to predict fat androstenone

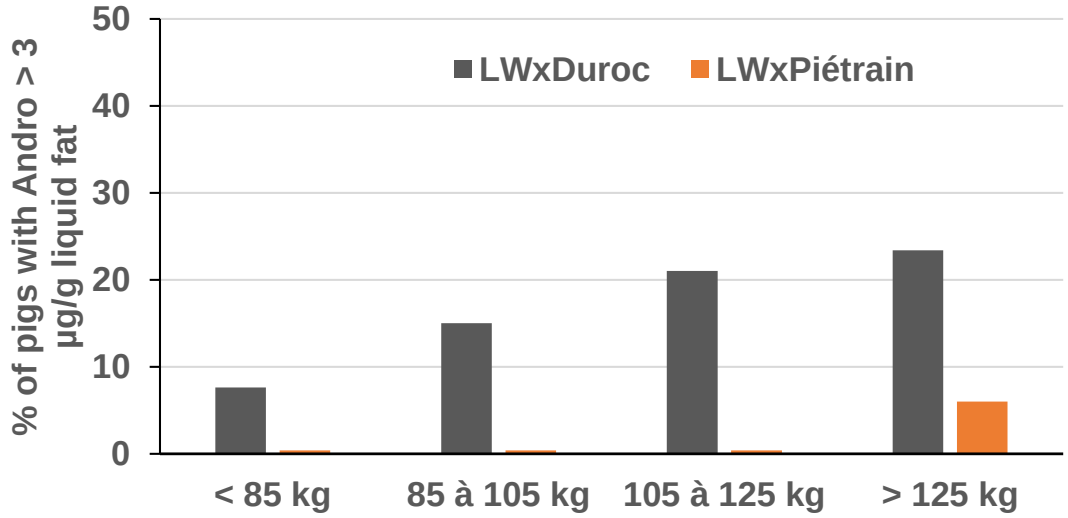
Estimation of risk for boar taint related to androstenone

≤ 50 pg oestradiol/ml plasma: close to 0

> 50 pg oestradiol/ml plasma: around 63 %

Effect of genotype and reduction of slaughter live weight on the risk for boar taint

Calculation of boar taint risk due to androstenone at given slaughter weight, *based on plasma oestradiol (with risk = 0 for plasma ≤ 50 pg/ml and risk = 63% for oestradiol > 50 pg/ml)*



- *Pietrain : very low risk below 125 kg, close to 6% above 125 kg live weight*
- *Duroc : **gradual increase of risk** from ≈ 8% below 85 kg to ≈ 23% above 125 kg*
- ***Risk due to skatole**: probably independent of live weight, low if good environmental conditions: clean animals (clean bedding) and good air renewal*

Conclusions – Study 1

Pig genotype: Duroc vs Pietrain crossbreeds

- Improvement of **some welfare indicators** for intact males

- Similar **growth performance** between both genotypes
- **Lower carcass leanness** (-> lower commercial value)

- **Higher technological quality** (i.e. ability for processing)
- Meat quality traits (intramuscular fat, shear force) suggest higher meat tenderness
- ***But* higher risk for boar taint** (androstenone)

Reduction of live weight at slaughter

- **Decreases the risk for androstenone**, especially for Duroc crossbreeds
- For both genotypes, avoid live weight above 125 kg

Animal management and feeding

Study 2

ifip — Institut du porc

- **Additional straw in the pen and incorporation of 10% alfalfa meal in pig diet : effects on health and welfare indicators and on boar taint**

  - Cleanliness of the pen contributes to reduce skatole content in backfat and the risk for boar taint *(Parois et al., 2018)*

  - Including crude fiber in the diet can reduce skatole production in the gut and may influence animal behavior ("positive" behaviours)

Experimental design

Commercial, organic pig farm

2 pig groups X 4 batches, total of 165 male pigs

- ***Control group**: organic diet*

- ***Test group**:*
  - *organic diet including 10% of alfalfa meal during the last month before slaughter*

And

  - *additional straw (+20%) in the pen and addition of straw 48 h before first departure to slaughterhouse*

- ✓ *Observations of health and welfare during rearing at 3 different times*
- ✓ *Carcass traits at slaughter*
- ✓ *Boar taint components in backfat*

Results

Indicators of health and welfare

Health: - Presence of coughing, of diarrhea
- Lameness; hernias…
- Mortality rate

Well-being: - Number of pigs with skin wounds, scratches
- Tail lesions
- Human-animal relationship…

➢ ***No significant differences between control and test groups***

Carcass traits

	Control	Test	Sign.
Hot carcass weight, kg	98.8	95.7	B**, T:ns
Lean meat percentage (slaughter weight as covariate)	59.2	59.8	B*, T:ns

(effect of treatment (T) and batch (B) **: $P < 0.01$ *: $P < 0.05$, ns: $P > 0.10$)

➢ ***The feeding regimen and animal management does not significantly influence carcass traits***

Boar taint components in backfat

	Control	Test	Sign.
Androstenone, µg/g liquid fat	1.18	0.74	T*
Skatole, µg/g liquid fat	0.15	0.06	T**
Percentage of pigs with			
Skatole > 0,15 µg/g	26	6	T***
Androstenone > 3 %g/g	9	1	T***
Score of human nose > 2	8	2	Tt

(effect of treatment (T), and batch (B) ***: P < 0.001, **: P < 0.01 *: P < 0.05, t: P < 0.10)

- ***Additional straw*** *in the pen and incorporation of* ***10% alfalfa meal*** *in pig diet led to* ***lower skatole and androstenone*** *contents in backfat, and* ***lower proportion*** *of carcasses detected as* ***tainted by human nose***

Conclusion

Animal diet and management are effective levers to reduce risk for boar taint (especially due to skatole)

General conclusions - 1

Two experiments with non-castrated males in organic farming

- Possible to produce non-castrated male pigs in organic farming with satisfactory growth performance and carcass traits
- Overall, in our experimental conditions, health and well-being indicators suggested satisfactory conditions for the animals
- The tested levers at farm level: genotype, slaughter weight; animal management and feeding, influenced the risk for boar taint, but had less impact on health and welfare indicators (except Duroc crossbreeds)

General conclusions - 2

Two experiments with non-castrated males in organic farming

- The risk for boar taint was relatively low in the first study, and higher for Duroc vs Pietrain crossbreeds - but with other positive effects on other meat traits: trade-offs!

- The risk was higher in the second study in the control group, but animal management and diet (test) can reduce the risk

➢ These results indicate that it is **possible to stop castration and rear non-castrated males in organic farming, provided that risks for boar taint (and aggressive behavior) are managed by genetics and farming practices**

PPILOW **PARTNERS**

Thank you for your attention!

benedicte.lebret@inrae.fr

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