Comparison of alternatives for the control and detection of boar taint in market hogs

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WHY NOT JUST KEEP CASTRATING?

Castration of piglets is a common practice in Canada, as in many other countries, to avoid boar taint in pork meat. There is, however, a growing interest in raising non-castrated males for animal welfare reasons and because intact males are more growth efficient than castrates. Sexual odors are caused by the accumulation of androstenone and skatole in adipose tissues. Androstenone is a steroid produced in the testicles at the onset of puberty and plays the role of a pheromone. Skatole is a result of the bacterial degradation of tryptophan in the intestine. Genetic selection to reduce sexual odors to a level acceptable to consumers is a potential solution to this problem. Past studies have demonstrated that the two compounds responsible for these sexual odors are moderately to highly heritable, suggesting that selection to reduce these odors in intact males is possible. Research led by Dr. E. James Squires at the University of Guelph has identified genetic markers associated with sexual odors, located on genes that code for the enzymes involved in the synthesis and degradation of androstenone and skatole. Research on these markers has suggested that they could be used to lower boar taint without adversely affecting reproductive traits. One objective of this study was to evaluate the potential of selection based on these genetic markers to reduce levels of androstenone and skatole in fat tissues in Canadian hogs. With this in mind, three commercial trials (two in Quebec and one in Manitoba) were conducted to determine if the selection of terminal boars, based on their genetic potential for sexual odors, had an impact on problematic odors in commercially bred offspring. If the industry is to consider the possibility of raising intact males, there are also important implications for cost of production and the type of carcasses produced. Therefore, a second objective was to compare performance and carcass attributes of the intact males with other sex groups. A third objective was to explore options for detection of boar taint in commercial packing plants. An effective and practical way to verify the absence of boar taint is important for assurance that pork from males meets customer expectations.

Table 1– Adjusted Averages, by sexual type, for principal traits measured between 30 and 130 kg (Quebec trials)

Trait	Unit	Number of pigs	F	Sexual Type [1] C	I	M	P [2]
Average Daily Gain	g/d	617	1 002a	1 063b	1 149c	1 080b	***
Average Daily Consumption	kg/d	622	2.50a	2.76b	2.74b	2.45a	***
Feed conversion ratio (feed/gain)	kg/kg	621	2.51a	2.60b	2.40c	2.28d	***
Carcass Weight	kg	611	104.6a	104.3a	102.4b	104.0a	***
Carcass Yield	%	616	81.9a	81.5ab	79.9c	81.3b	***
Back Fat (ultrasound)	mm	620	14.6a	17.0b	15.9c	14.0a	***
Muscle Thickness (ultrasound)	mm	620	70.3 a	69.4 a	69.2 a	69.3 a	-
Lean Yield	%	616	61.8a	60.8b	60.3b	61.7a	***
Loin Eye Area	cm2	590	54.6a	50.8b	50.7b	52.8ab	***
Colour Score (loin)	points	614	4.33a	4.22a	4.21a	4.54b	***
Marbling Score (loin)	points	614	2.42a	2.65b	2.52ab	2.19c	***
24-hour pH (loin)	pH units	611	5.74a	5.74a	5.75a	5.79b	***
Water Loss (loin) – log scale	%	613	0.87a	0.66b	0.77ab	0.77ab	***
Androstenone – log scale	g/g	608	-2.16a	-2.22a	-2.09a	0.39b	***
Skatole – log scale	ng/g	608	2.01a	1.99a	2.11a	3.54b	***

1 Codes for sexual type: F=females, C=castrated males, I=Improvest® treated males, M=intact males; averages affected by the same letter (a, b, ab) are not significantly different (P > 0.05);

2 *** P < 0.001; ** P < 0.01; * P < 0.05; t P < 0,10

Table 2 – Adjusted Averages, by sexual type, for principal traits measured between 30 and 130 kg (Manitoba trials)

Trait	Unit	Number of pigs	F	Sexual Type [1] C	I	M	P [2]
Average Daily Gain	g/d	1 056	935a	995b	1 054c	997b	***
Average Daily Consumption	kg/d	1 056	2.54a	2.90b	2.97b	2.53a	***
Feed conversion ratio (feed/gain)	kg/kg	1 056	2.71a	2.91b	2.82b	2.54c	***
Carcass Weight	kg	89	109.1a	109.8a	108.5ab	106.3b	**
Carcass Yield	%	89	80.4a	81.0a	80.0ab	78.4b	**
Back Fat (ultrasound)	mm	242	17.9 a	19.3 a	20.8 a	17.0 a	t
Muscle Thickness (ultrasound)	mm	242	71.7a	67.5ab	66.7b	69.8ab	*
Lean Yield	%	89	63.5ab	62.2bc	61.8c	64.6a	***
Loin Eye Area	cm2	89	67.2 a	64.1 a	62.7 a	63.7 a	-
Colour Score (loin)	points	89	2.51 a	2.46 a	2.44 a	2.56 a	-
Marbling Score (loin)	points	89	1.70 a	1.91 a	1.91 a	1.62 a	t
24-hour pH (loin)	pH units	89	5.70 a	5.74 a	5.71 a	5.74 a	-
Water Loss (loin) – log scale	%	89	0.51 a	0.43 a	0.64 a	0.71 a	-
Androstenone – log scale	g/g	280	-1.59a	-1.63a	-1.65a	1.38b	***
Skatole – log scale	ng/g	280	1.46a	2.14a	2.05a	3.56b	**

1 Codes for sexual type: F=females, C=castrated males, I=Improvest® treated males, M=intact males; averages affected by the same letter (a, b, ab) are not significantly different (P > 0.05);

2 *** P < 0.001; ** P < 0.01; * P < 0.05; t P < 0,10

COMMERCIAL TRIAL RESULTS FOR GILTS, CASTRATES, IMPROVEST® TREATED MALES AND INTACT MALES

Duroc boars active in three Canadian artificial insemination centres were genotyped for 103 genetic markers and ranked on their genetic potential for boar taint levels. A total of 1,660 commercial pigs born from boars with either low or high potential for androstenone were raised from weaning to slaughter in commercial trials. Two trials were carried out in Quebec (Table 1) and one in Manitoba (Table 2). Each trial included females (F), castrates (C), intact males (M) and Improvest® treated males (I). The pigs were tested from 30 to 130 kg live weight and tracked at the packing plant for carcass and meat quality measurements. Results show sex differences in line with those in the literature for live performances, including a faster growth for I animals due to a higher feed intake, whereas intact males showed the best feed efficiency, followed by F animals, then C and I. Lean yield was higher in M and F compared to C and I. Loin muscle area was higher in F compared to the three male groups. There were significant differences found in the Quebec trials for loin marbling, colour, pH and water loss. These were not significant in the Manitoba trial, possibly due to smaller numbers of loins evaluated. Androstenone and skatole levels on average were similar and low in F, C and I, while being significantly higher in M, as expected. Large differences were seen between trials for boar taint levels and thus environment and management will be important considerations for avoiding boar taint in intact males.

POTENTIAL FOR GENETIC SELECTION TO ELIMINATE BOAR TAINT

Differences between high and low boar taint groups were in the expected direction for androstenone and skatole levels in fat tissue. In other words, the litters sired by the low boar taint Durocs had a higher percentage of intact males with androstenone and skatole with acceptable levels for consumers. This was the case in both the Quebec and Manitoba trials. However, the differences were relatively low and not significant in most cases. The results are, nevertheless, encouraging considering this study was with limited numbers of intact males and only considered the effect of the terminal sire (Duroc) on boar taint. Evaluation in maternal breeds (Yorkshire and Landrace) can also be considered. Further, during the course of this study, many new genetic markers have been identified. Genetic evaluation methods for boar taint will be enhanced with the use of additional genetic markers and a better understanding of mechanisms involved in crossbred animals. This additional research is expected to increase accuracy of genetic evaluation and allow for a better assessment of genetic selection as a potential alternative to control boar taint. Additional commercial validation trials should be conducted which could also consider behaviour and welfare aspects of raising intact males.

DETECTION OF BOAR TAINT IN COMMERCIAL HOGS

Two methods for detection of boar taint were tested against reference chemical analysis for androstenone and skatole. The first method was the human nose with trained panelists, a method currently used in slaughter plants in the European Union. Trained panelists evaluated batches of fat samples in several monthly sessions in a lab, or "protected", environment. The panelists were able to differentiate high from low boar taint in 65 to 92% of samples, depending on the month. The second method was a novel approach using DNA aptamers, which are single strands of DNA that fold into unique shapes depending on the DNA sequence. Research led by Dr. Maria DeRosa at Carleton University went through a process to find and select aptamers that bind well and exclusively to skatole and androstenone. The next step was the development of a lateral flow assay, similar to a pregnancy test strip. In a preliminary trial using the lateral flow assay, the DNA aptamers gave correct results on 14 of 15 samples. Further validation is planned and options for development of DNA aptamer test kits for commercial use are being considered.

(Comparison of Alternatives ... cont'd on page 11)

Table 1. Audit results from farms with group sow housing systems, 9 farms

Category	Average Percentage of Farms		
*Are all Sows fed same gestation diets**	*21 %*	*79 %*	*0 %*
Time of Group Formation	*100 %*	*0 %*	*0 %*
Sows are Sorted by Size (room or pen)	*100%*	*0%*	*0%*
Type of enrichment used	*88 %*	*13 %*	*0 %*

Legend
- Meets recommendation
- Partially meets recommendation
- Does not meet recommendation

ratios to cover the intermediate amino acid needs, with increasing amounts fed the last four weeks of gestation. The biggest challenge regarding the implementation of this strategy is to ensure a minimum of two feed lines are available for each electronic feeding station. As seen by the results in Table 1, only one farm has adopted this technology.

Timing of group formation is essential for ensuring high productivity from the sow herd. Groups should be formed prior to day 7 or after day 28 due to the importance of implantation. Results indicate that 100% of farms were compliant. Feedback from producers involved in the group sow housing process also indicates that they are becoming more comfortable mixing sows earlier than day 7 which, in turn, reduces the total number of stalls required on the farm. Research on the grouping of sows in non-competitive housing shows there are benefits to keeping sows in uniform groups, especially for younger sows. Sows in uniform groups demonstrated less instances of lameness after mixing compared to sows kept in mixed (non-uniform) groups[2].

Within the Code of Practice for the Care and Handling of Pigs (2014)[3], enrichment is considered to be a recommended practice within group sow housing systems, specifically as a way to minimize aggression. Taking a look at the data we can see that eight of nine farms audited have incorporated some type of enrichment, typically chains or wood, within their operation. According to the Code, enrichment should be simple, safe, soft, sanitary, suspended and well-positioned. More information can be found in Appendix H within the Code.

Conclusion

Data indicates that approximately 15% of the Canadian sow herd has made the transition to group sow housing. For those producers looking to make the transition, many resources can be accessed at your fingertips by visiting the website www.groupsowhousing.com. Here you will find a wide variety of information that will help you make the best choice possible for your operation.

For Further Reading

1 Phase Feeding for Gestation Sows
(Francais) http://www.cdpq.ca/getattachment/Recherche-et-developpement/Projets-de-recherche/Projet-224/PQ-juillet-2017-224.pdf.aspx
http://www.cdpq.ca/recherche-et-developpement/projets-de-recherche/projet-224.aspx
(English) http://www.cdpq.ca/getattachment/Recherche-et-developpement/Projets-de-recherche/Projet-224/CHJ-Summer-2017-projet-224.pdf.aspx
(English) http://www.prairieswine.com/phase-feeding-for-pregnant-sows/

2 Effects of Mixed and Uniform Parity Groups on Feeding Behaviour, Welfare and Productivity of Sows in ESF Housing
(English) http://www.prairieswine.com/effects-of-mixed-and-uniform-parity-groups-on-feeding-behaviour-welfare-and-productivity-of-sows-in-esf-housing/

3 Code of practice for care and handling of pigs
(Francais) http://www.nfacc.ca/pdfs/codes/porcs_code_de_pratiques.pdf
(English) http://www.nfacc.ca/pdfs/codes/pig_code_of_practice.pdf

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TAKE HOME MESSAGES

Many recent studies have compared intact males and castrates, or castrates and Improvest® treated males. This study is rare in that it includes females, castrates, Improvest® treated males and intact males from the same litters, all tested under similar conditions. These comparisons provide valuable information on differences that can be expected for both producers and packers to plan for and make decisions related to options for control of boar taint.

This study confirmed the advantages of raising intact males in terms of growth performance compared to females and castrates. Improvest® treatment is an interesting option because it gives the benefit of improved growth performance of intact males while producing carcasses of similar composition to castrates.

Genetic selection based on specific genetic markers shows potential for producing intact males with naturally low enough levels of androstenone and skatole to avoid boar taint problems. However, more research is needed on genetic evaluation methods, consideration of influence of genetics from the maternal breeds and to incorporate newly identified genetic markers. The impact of management and environment also needs to be considered as large differences in the levels of boar taint were observed between trials. The combination of management and genetics could result in lower and lower probability of carcasses from intact males having boar taint.

A new technology based on DNA aptamers shows great promise to lead to a reliable, practical and affordable screening test for boar taint. This could be in the form of a simple kit similar to a home pregnancy test available for humans. The ability to screen for boar taint combined with genetic selection to lower the frequency of intact males that have boar taint problems could lead to a viable alternative for control of boar taint.

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