Boar Taint - Can we breed it away or do we cut it away?

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Introduction

Boar odour or boar taint is an undesirable "perspiration-like" odour that can be given off by meat from intact boars when subjected to heating/cooking. Surgical castration at an early age of boars intended for market has long been an accepted practice by the pig industries of many countries to avoid this quality effect in the pork they produce. Unfortunately, barrows (castrated boars) are at a disadvantage relative to boars when production traits are considered. Hansen and Lewis (1993) estimated the advantages of boars over barrows (at dietary protein levels being used for commercial production in the USA) were: a 5.2% decrease in voluntary feed intake, a 2.5% increase in average daily gain, an 11% reduction in average backfat and a 5.5% advantage in feed efficiency. These estimates were for weight gains from 19 to 105 kg. Many pig industries have foregone these advantages and market primarily barrows, giving severe penalties to the producer selling intact males.

The current Australian pig industry has been unwilling to forego these production advantages from raising boars for market and stopped castrating males approximately 20 years ago (Hennessy and Wan, 1993). These authors felt the main reasons for this decision were: "the production benefits associated with entire male pigs and the fact that, at the time, it was believed that because of the relatively light weights at which pigs were slaughtered in Australia, the domestic consumer would not discern a problem with 'boar odour'." These authors also noted that future concerns and challenges for the Australian pig industry in this area would arise if the industry wanted to: (1) increase exports to Asian markets; or (2) slaughter animals at heavier live weights to take advantage of the high relative growth efficiency of intact males and reduce per animal processing costs at abattoirs. If the above points are goals for the Australian pig industry, it will need to consider some of the potential avenues that have been suggested to deal with boar odour. Some of these avenues are:

1. Surgical castration at an early age;
2. Immuno-castration;
3. Alteration of feeding regimes close to market;
4. Housing/sanitation considerations;
5. Genetic selection;
6. Abattoir identification of affected meat for further processing;
7. Identify markets where consumers have no preference regarding boar taint.

Since this is a pig genetics workshop, it is beyond the scope of this presentation to discuss all of the above avenues, and this paper will mainly deal with the possibilities of reducing the effects of boar odour through genetic selection.

Genetic selection

In genetic selection/breeding programs, two basic steps are involved: (1) selection of breeds/lines to be used in the program; and (2) selection of animals within lines to improve the economic traits of interest. The two major compounds which appear to be the causative agents for boar odour are androstenone and skatole, and Willeke (1993) reviewed the literature relative to breed differences for 5α-androstenone in carcase fat.

Results from that review are presented in Table 1. Willeke (1993) noted that the threshold level of androstenone where boar odour/taint is evident is 1.0 µg/g fat, and one can see from this table that some breeds are well above this threshold level, while others are well below. Breeds with the highest levels of androstenone were the Pietrain, Large White and Swedish Landrace, although it should be noted that these higher estimates were from studies that slaughtered boars at heavier weights. The Large White breed is very prominent in most Australian pig breeding programs. This population has been fairly isolated during the last 20 years, and extrapolating the results from Table 1 to Australian Large White populations should be done with caution. If the Australian pig industry determines to use genetic selection and breeding programs to reduce the effects of boar odour in the pork it produces, it will need to initiate pilot studies that characterize the levels of androstenone in boars slaughtered at various weights for the major breeds/lines being used in the industry. These pilot studies would provide information on breed averages of current androstenone levels and identify breeds that had the potential to produce boars with unacceptable levels of boar odour if slaughtered at heavier weights.

Table 1. Summary of breed differences of 5α-androstenone in carcase fat (from Willeke, 1993)

Breed	**Body weight (kg) (days)or age**	**5α-androstenone content (µg /g fat)**	
		Mean	**Standard Deviation**
Pietrain	100kg	1.75	
Belgian Landrace	100kg	0.61	
Danish Landrace	87kg	0.94	0.7
Danish Landrace	90kg	0.71	
Large White	104kg	1.38	0.33
Large White	124kg	1.68	0.37
German Edelschwein	180days	0.6	0.55
German Landrace	180days	0.89	0.82
German Landrace	170days	0.28	0.22
German Landrace	190days	0.44	0.67
German Landrace	210days	0.54	0.76
Swedish Yorkshire	110kg	1.26	0.94
Hybrids	90kg	0.49	

The second basic step in genetic improvement programs is selecting animals within lines to improve the genetic mean of the breed/line. To facilitate this selection there must be genetic variation for the trait of interest for the breeder to be able to differentiate between superior and inferior selection candidates. Willeke (1993) has reviewed the literature for heritability estimates of 5α-androstenone content in fat for different breeds and results are summarized in Table 2. Note that, with the exception of one study, these heritability estimates are very high indicating a distinct possibility of being able to select for animals with reduced androstenone. Willeke *et al* (1987) demonstrated this in a divergent selection experiment where boars were selected for high or low androstenone concentrations in fat for 5 generations. These researchers found a realized heritability of .56 + 0.11. Could this approach be used in Australian pig populations so that the economic advantage of raising boars is maintained while avoiding some of the problems of boar taint in the pork produced?

Table 2. Summary of heritability estimates of 5α-androstenone content in fat for different breeds (from Willeke, 1993)

Breed	Method of estimation	$h^2 \pm$ s.e.
Danish Landrace	Variance Component	0.54 ± 0.32
Danish Landrace	Variance Component	0.25 ±0.13
Danish Landrace	Variance Component	0.81 ±0.21
Large White	Variance Component	0.61
Large White	Realised h^2	0.76 ± 0.47
German Landrace	Realised h^2	0.56 ±0.11

To answer that we need to make some assumptions regarding current levels of androstenone in Australian pig populations, selection intensities applied and the amount of genetic variation that is present. Using the Large White breed as an example, results from Table 1 would suggest that for a slaughter weight of 104 kg the androstenone level would be approximately 1.4 μg /g fat. If the threshold level where taint is evident is 1.0, the population mean would need to be reduced by .5-.6 μg /g fat. If we assume that only the top 5% of boars are selected, no selection is possible on the female side, a heritability for the trait of .6, and a phenotypic standard deviation of 0.35 (Table 1), the predicted response per generation can be calculated using the formula of Falconer (1989).

$$R = i\,h^2\,\sigma\rho$$
$$= 1.0315 \times .6 \times .35$$
$$= .22\ \mu g/g\ \text{fat/generation}$$

This would indicate that it would take approximately 3 generations of intense single trait selection to reduce levels of androstenone in carcase fat in boars in the nucleus level. This result is in agreement with the findings ofWilleke et al (1987). With a generation interval of 2 years this would amount to 6 years. Assuming another 2 years lag to disseminate this improvement to the commercial level, this program would take a total of 8 years. This estimate assumes the current average level of androstenone in boars from Australian pig populations is 1.4 μg /g fat. If average levels are substantially less than this as determined by pilot studies on representative populations, the time required to reduce those levels to acceptable ranges through genetic selection would be less.

The above estimate also assumes that single trait selection is practiced. We do not currently have reliable information regarding genetic correlations between 5α-androstenone levels in fat and other production traits of economic importance. In a review of steroid pathways affecting boar odour Brooks and Pearson (1986) noted that selection experiments to reduce androstenone levels in boars (Jonsson and Andresen, 1979; Willeke *et al*., 1980) also resulted in decreased concentrations of testosterone. This raises the question of whether the economic benefit from raising boafs to market would be compromised by selection for reduced levels of 5α-androstenone. It also raises the question of whether the selection intensity assumed above (top 5% of boars) could be maintained, since reduced testosterone levels in boars might impair reproduction capabilities such as sperm production or libido to mount AI dummies or sows. These issues have yet to be answered by further research.

Another issue that would need to be addressed by the Australian pig industry, if it decided to use genetic selection to deal with boar odour is: does it have 8 years to implement the above program (if assumptions in the above discussion hold)? If the goal of the industry is increase exports to Asian markets, consideration will have to be given to other pig industries that are also seeking to further develop those export markets. In North America and most European countries, surgical castration of young boars intended for market is routine, and slaughter weights are higher than in the Australian market (at the North Platte station we currently market our barrows and gilts at about 120 kg liveweight with 25 mm of backfat). This gives these industries an advantage in reduced processing costs per animal and avoids the problems of boar taint in the pork produced. The Australian pig industry is aware of the importance of pork quality in its ability to compete in the global market, as evidenced by the work of Hermesch *et al* (this workshop), but the issue of boar taint must also be resolved if Australia is to compete in the global market in a timely manner with industries that are castrating market boars.

Alternatives to breeding

It would appear from the above considerations, that, to answer the title I was given for this presentation, "Boar Taint - Can we breed it away or do we cut it away?" genetic selection is possible as an avenue in dealing with boar taint, but there may be better alternatives. The time frame to implement the genetic solution may be too long, and effects of correlated responses to selection for reduced androstenone levels in fat are unknown. Bonneau *et al* (1994) described an experiment on the effects of immunizing boars against Luteinizing Hormone-Releasing Hormone (LH-RH) on performance, sexual development and levels of boar taint-related compounds. Results from this study indicated that levels of androstenone in fat in intact males could be substantially reduced while having little effect on performance characteristics such as growth rate and carcase traits. If Australian producers are unwilling to adopt surgical castration as a remedy to boar taint, due to economic loss from feeding barrows vs boars, risk of infections and animal welfare considerations, the above study would suggest that immuno-castration might be an alternative to this problem. Availability or cost of implementing the LH-RH immunization at the commercial level is unknown, but the results of Bonneau *et al.* (1994) do suggest further examination of this alternative. Hennessy and Wan (1993) noted that procedures for screening carcasses at slaughter are being developed, and this might also be a fruitful avenue to pursue. Danish slaughter plants routinely screen carcasses for levels of skatole (D. Reese, personal communication), and similar procedures for skatole and androstenone might be implemented in Australian abattoirs. This would allow affected meat to be targeted for further processing into small goods and pork free of boar taint targeted for export. This depends of the ability to incorporate the screening procedures into practical abattoir conditions.

Conclusions

The Australian pig industry is well positioned to develop Asian export markets with its proximity to Asia, its relatively lean genotypes, and its grain reserves, but timing will be important in developing those markets as competition between various pig industries will increase. Asian populations do discriminate against pork with boar taint (Hennessy and Wan, 1993), and if Australia is to produce acceptable pork products for Asian markets or for domestic consumption by Asians, visiting Europeans or wandering Yanks, it will need to select one of the above mentioned avenues, a combination of those approaches or novel procedures to resolve how it deals with the boar taint issue in the next 2-4 years.

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