The effect of age and distribution of skatole levels in purebred boars in Sweden

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Background

The utilization of entire (uncastrated) male pigs in Sweden and most other countries is limited due to the presence of off-flavour in meat from some entire male pigs referred to as boar taint. Entire males compared to castrates have superior production characteristics. They utilize feed more efficiently offering a more sustainable and more profitable production system. In eliminating castration animal health and welfare aspects are equally important.

Boar taint or boar odour occurs in some entire male pigs at slaughter weight. It is caused by accumulation in fat of at least one of the two compounds, skatole (3-methylindole) produced by bacteria in the hind gut of pigs or androstenone synthesized in testes.

The levels of skatole in fat are influenced by environment and diet, as well as by the age of pigs. However, the levels of skatole are also under genetic control as indicated by breed and genetic effects, including significant heritability estimates (Pedersen, 1998). These effects might be due to genetic polymorphism of the enzymes responsible for skatole metabolism in the liver (Babol et al., 1998). There are indications of a presence of major genes affecting boar taint level (Lundström et al., 1994).

Objectives

In this study, the possibility of a presence of a major gene affecting skatole levels was investigated. This was performed by evaluating the distribution of skatole levels in purebred boars. Also, the age effect on skatole levels and the frequency of occurrence of high skatole levels in Swedish breeding population were examined.

Materials and Methods

Blood plasma samples were collected at different ages from purebred boars intended or used for breeding (Swedish Meats, Quality Genetics), and were analyzed for skatole concentrations for a total of 134 Landrace, 72 Yorkshire and 68 Hampshire boars. In addition, samples from 15 Landrace boars collected at two different ages were analyzed. For 37 boars the levels of skatole were measured both in plasma and in fat to obtain a regression equation between these measurements. Levels of skatole in fat were measured by a colorimetric procedure (Mortensen and Sørensen, 1984) and in plasma by HPLC (Claus at al., 1993).

Results and discussion

Figure 1 and 2 presents the frequency distribution of plasma skatole levels in Landrace and Hampshire boars, respectively. Because of the discussed below age effects on skatole levels samples taken from boars at the age from 190 to 250 days for Landrace and from 190 to 310 days for Hampshire were used to plot theses figures. Normal distribution would suggest a polygenic trait, i.e. a trait affected but several genes. Polymodal distribution, indicated in the figures, could suggest involvement of a major gene in regulating levels of skatole in boars. Similar distribution of skatole plasma levels was observed in Yorkshire boars (data not shown).

In all breeds a clear effect of age on skatole levels was observed. In Figures 3 and 4, plasma skatole levels are plotted against the age of pigs for all Landrace and Hampshire boars, respectively. Other studies indicated that skatole levels increase in male pigs at puberty. This study shows that in Landrace boars this increase occurs in some pigs at the age of 190 to 250 days, while in other pigs the levels remain low. After 250 days the levels decrease. The fact that skatole levels are reduced at older age was confirmed by comparing the levels in samples taken twice from the same animal at different ages. In Landrace boars (n=15), at the mean age of 210 days the mean skatole level was 16.9 μg/L (SD=17.34) compared to 5.9 μg/L (SD=3.48, p=0.024) at the mean age of 314 days. The individual age dependent changes in skatole levels are presented in Figure 5.

The decrease of skatole levels in older (mature) boars has not been reported previously. It stresses the importance of the time of taking skatole measurements in order to evaluate the potential for boar taint. The time of peak skatole concentrations coincides with the time of puberty. This provides an additional evidence of the possible impact on skatole levels and metabolism of hormonal changes occurring at puberty (Babol et al., 1999). Because there are differences in time of the onset of puberty among the studied breeds (M. Wallgren, pers. com.) the time when skatole concentrations reach their maximum may vary depending on breed. The later maturing Hampshire boars appear to reach maximum skatole concentrations at older age (Figure 4) than Landrace boars (Figure 3).

The level of 0.20 ppm of skatole in fat, currently used in Sweden as a threshold level for selecting tainted carcasses, corresponds to approximately 12.6 μg/L of skatole in plasma. 67 % of Landrace, 75% of Yorkshire (age, 190 - 250 days) and 62% of Hampshire boars (age, 190 - 310 days) had skatole levels below this limit. This indicates that the frequency of high skatole levels is relatively low in the investigated breeds for a selection against high skatole to be practically achievable.

Conclusions

The results from this study indicate a non-normal distribution of skatole plasma levels in boars. This might suggest a presence of a major gene controlling skatole levels. Skatole concentrations markedly decrease after puberty. Thus, it appears that skatole levels increase until puberty, when they reach maximum, and then decrease. This age effect must be taken into account when considering the time of skatole measurements to be taken in order to obtain the true potential for boar taint due to skatole. The frequency of high levels of skatole in Swedish breeding animals seems to be reasonably low indicating that, if appropriate markers are found, it could be feasible to select against high skatole levels.

References

Babol, J., Squires, E. J. and Lundström, K. 1998. Relationship between oxidation and conjugation metabolism of skatole in pig liver and levels of skatole in fat. J. Anim. Sci. 76:829-838.

Babol, J., Squires, E. J., and Lundström, K. 1999. Relationship between metabolism of skatole and androstenone in intact male pigs. J. Anim. Sci. 77:84-92.

Claus, R., Dehnhard, M., Herzog, A., Bernal-Barragan, H., and Gimenez, T. 1993. Parallel measurements of indole and skatole (3-methylindole) in feaces and blood plasma of pigs by HPLC. Livest. Prod. Sci. 34:115-126.

Lundström, K., Malmfors, B., Stern, S., Rydhymer, L., Eliasson-Selling, L., Mortensen, A. B., and Mortensen H. P. 1994. Skatole levels in pigs selected for high lean tissue growth rate on different protein levels. Livest. Prod. Sci. 38:125-132.

Mortensen, A. B., and Sørensen, S. E. 1984. Relationship between boar taint and skatole determination with a new analysis method. Proc. 30th Eur. Meet. Meat Res. Workers, Bristol, Paper 8-11, p 394.

Pedersen, B. 1998. Heritability of skatole in back fat. (Chapter 7) In: W. Klinth Jensen (Editor) Skatole and Boar Taint. Danish Meat Research Institute, Roskilde, Denmark, pp 129-136.

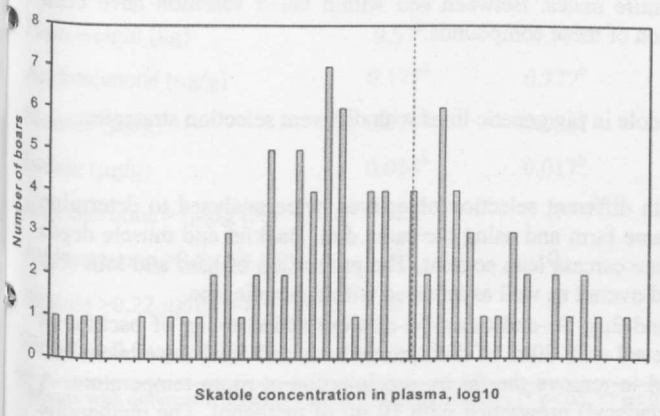

Figure 1. Frequency distribution of plasma skatole levels in Landrace boars (n = 87). Boars to the right of the dashed line have skatole levels above the threshold level of 12.6 µg/L, which corresponds to 0.20 ppm of skatole in fat.

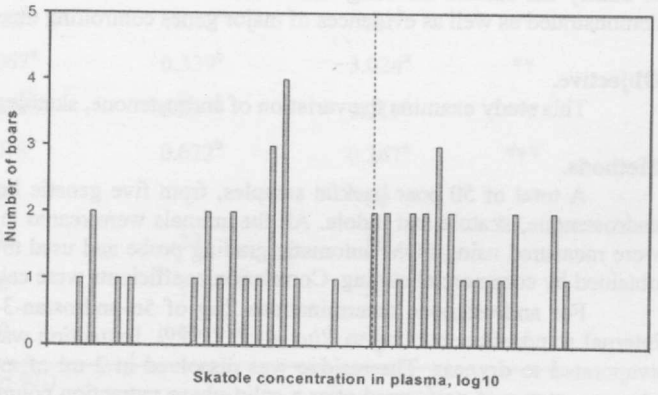

Figure 2. Frequency distribution of plasma skatole levels in Hampshire boars (n = 45). Boars to the right of the dashed line have skatole levels above the threshold level of 12.6 µg/L, which corresponds to 0.20 ppm of skatole in fat.