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SKATOLE LEVELS AS AFFECTED BY INHERITANCE AND SEASON

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INTRODUCTION

Interest in using entire males for meat production has increased recently thanks to the possibility of using skatole analysis as an objective on-line test for boar taint. However, the incidence of carcasses with high skatole levels varies between herds and also between seasons. The mode of inheritance for skatole deposition in backfat of entire male pigs has not yet been confirmed. Skatole is degraded in the liver (Agergaard and Laue, 1993), and the increased skatole deposition in backfat may be due to a less effective degradation. Recent results from Sweden suggest that a recessive gene with incomplete penetrance may be involved (Lundström *et al.*, 1993). Incomplete penetrance might therefore be due to the fact that the skatole `load' needs to be quite high before the degradation system becomes overloaded.

The purpose of the present investigation was to study skatole levels in entire male pigs slaughtered either in the spring or in late autumn, using the same sires and dams for all four batches.

MATERIALS AND METHODS

Animals

The present study comprised two years' production of entire male pigs in a commercial herd in southern Sweden. An "all in/all out" system was used, with one slaughter period in the spring and one during late autumn. The study material comprised 628 entire male pigs, all descended from two Hampshire boars used throughout the period. The sows were Landrace x Yorkshire crosses and were also used throughout the period, except for normal replacement. The present study included altogether 53 sows, with 31 having at least three litters each.

After weaning at seven weeks, each litter was kept as a unit with both sexes in the same pen. In litters with more than nine pigs, however, the smallest animals were transferred to separate pens, and mixed with other small pigs from large litters. The feed used was a commercial feed mixture. The pigs were kept on a concrete floor, both in the lying and in the dung area. The ventilation system was rather old and therefore not very efficient. The pigs were sent to slaughter at average live weights of 107kg (males) and 110kg (gilts). As gilts and entire male pigs were slaughtered at different weights, the production characteristics are not quite comparable and therefore not presented for the gilts. Growth rate from birth to slaughter was calculated from the slaughter weight, using an assumed dressing percentage of 73%.

Skatole analyses

Skatole (expressed as ppm in fat, wet weight) was analyzed in backfat taken from the neck region from the entire male pigs, using the spectrophotometric method developed in Denmark (Mortensen and Sorensen, 1984). This method is not specific for skatole and compounds with chemical characteristics similar to skatole (e.g., indole) can interfere.

Statistical analyses

All calculations were performed using Statistical Analysis System (SAS Institute Inc., 1989). Factors affecting skatole levels in male pigs were tested using a model including the effects of sire, dam and batch. The effect of skatole level on production characteristics was tested using the same model, but also including the effect of skatole level (<0.20ppm or ≥0.20ppm).

RESULTS AND DISCUSSION

The overall frequency of high skatole levels (≥0.20ppm) in backfat from the entire male pigs was 15.9%. The skatole levels were influenced by season to a very high degree ($P \leq 0.001$), with the frequency of high skatole levels being 24.4% at spring slaughter and 10.1% at autumn slaughter. The inter-season difference in the frequency of high skatole levels was consistent for the two years. Hansen *et al.* (1993) also found a much higher incidence of enhanced skatole levels in summer than in winter (39% vs 3%), when pigs were kept at a high stocking density in pens heavily fouled with faeces. One week in a clean environment was enough to reduce the skatole concentrations to acceptable values. In our study the pigs were kept on a concrete floor, in both the lying and the dunging area, with a rather inefficient ventilation system. The enhanced skatole levels during the summer may therefore be attributable to a higher skatole load from faeces at a high ambient temperature. It is still not proven that skatole is taken up from the faeces through the skin or via the lungs. Recent results by Hansen *et al.* (1993), where higher levels of skatole were found in the inner layer than in the outer layer of the subcutaneous fat tend to confirm uptake through the lungs.

The two Hampshire boars used during the whole period, had similar frequencies of progenies with high skatole levels, 14.6 vs 17.3%, and the difference in their mean values was not significant ($P > 0.05$). The dams, on the other hand, had a highly significant influence on skatole concentrations in their male offspring ($P \leq 0.001$). 31 sows in the study were represented with at least three litters each. Of these 31 sows, seven did not have any offspring with a high skatole level, while three had at least one offspring with an enhanced skatole concentration in every litter.

In a previous Swedish study (Lundström *et al.*, 1993) we found distinct differences in skatole levels between progenies from different sires, with a pattern indicating influence from a single gene. These pigs were fed a low-protein diet containing yellow peas which probably had a triggering effect causing the animal's genetic disposition to come to expression. Nonboe (1991) also found a pronounced effect of litter when feeding diets containing by-products from the brewing industry. In our present study, there was a large variation in skatole between dam progeny groups but also variation in the frequency of high skatole levels between different litters from each individual sow. The pattern was less distinct, however, than in our previous study and did not give any further evidence of a single-gene inheritance for skatole. It is possible that the genetic disposition of the animals was more readily manifested due to the constant stimulation of a triggering diet, as in our previous experiment. In the present study, the triggering factor, temperature, varied within season which might explain the somewhat scattered inheritance pattern observed.

Production characteristics differed significantly between male pigs with low vs high skatole levels in our study. Entire male pigs with a low skatole level had on average a higher growth rate, lower age at slaughter and higher lean meat percentage although carcass weights were the same as in the high skatole group (Table 1). The poorer production characteristics observed in the high-skatole group in our study is an interesting finding. Generally speaking, no relationship between skatole and production traits has been reported even though a relationship between low lean percentage and high skatole concentrations was observed in one Danish study (Mortensen, 1984; cit. Lundström *et al.*, 1985). Also in the present study, correlations between skatole and the production traits were non-significant except for a negative correlation with lean meat percentage ($r=0.17$; $P \leq 0.001$). The classification into two skatole groups may demonstrate such relationships more effectively.

The underlying cause of the poorer production results of male pigs with high skatole levels could be a connection between sexual maturity and skatole. In male pigs, the size of the bulbo-urethral glands, and sometimes also the level of the boar taint steroid androsterone, increases with puberty (Claus, 1979). Skatole has been shown to be positively

correlated to the length of bulbo-urethralis (Bonneau *et al.*, 1992) and to a varying extent also to the level of androsterone (e.g., Lundström *et al.*, 1988; Bonneau *et al.*, 1992). It has also been shown that sexual maturity affects production traits. For example, sexually mature gilts have a lower growth rate and are less lean than non-mature gilts (Eliasson-Selling and Andersson, 1992). Thus it seems likely that sexual maturity in male pigs has an influence both on production characteristics and on skatole deposition. Another possibility is that if a high skatole value is due to a less effective general detoxification system, this may also impair growth rate and protein accretion.

CONCLUSION

The results obtained from this commercial herd neither prove nor contradict the hypothesis of a recessive inheritance for skatole deposition. The seasonal differences in frequency of high skatole levels may reflect that the penetrance of the proposed `skatole gene' is dependent on the skatole load. The advantage in production traits for the entire male pig with low skatole levels may be due to a connection between skatole production/degradation and puberty.

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Table 1. Production characteristics in entire male pigs with low or high skatole values on backfat (least squares means ±SE).

Trait	Skatole concentration <0.20ppm	≥0.20ppm	Sig. level[2]
Number	526	102	
Growth rate[1], per day	634 ± 2	612 ± 5	**
Age at slaughter, days	169 ± 1	173 ± 1	***
Carcass weight, kg	78.1 ± 0.1	78.4 ± 0.3	NS
Lean meat, %	60.8 ± 0.1	60.2 ± 0.1	***

1 From birth to slaughter.
2 Levels of significance: NS=not significant; **=P<0.01; ***=P<0.001.