Age related patterns of plasma skatole levels in relation to sex hormones and triiodothyronine in entire male pigs

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Background

Skatole (3-methylindole) is one of the main contributors to boar taint. Due to its lipophility skatole can easily accumulate in the adipose tissue and cause off-odour. The threshold level, above which taint can be detected by consumers, was suggested to be 0.20 ppm in fat. Generally, boar taint occurs in a rather small portion of entire male pigs.

Feeding system and environment are important factors influencing skatole levels in entire male pigs. However, there are indications of genetic control of skatole levels (Lundström et al., 1994). Skatole levels increase with weight and age (Babol et al., 2000). The reasons for age effect on skatole levels are not known. Since skatole is not accumulated in gilts and barrows in increased amounts, the age effect could be due to regulation of skatole metabolism by sex hormones (Babol et al., 1999) or thyroid hormones, which are involved in the control of growth and development.

Objectives

The aims of the present study were to evaluate age effect on skatole levels and to investigate the relationship between skatole and testosterone, estradiol-17β, estrone sulphate and dehydroepiandrosterone sulphate (DHEA sulphate). The possible relationship between skatole levels and a thyroid hormone, triiodothyronine (T_3), was also investigated.

Materials and methods

Six crossbred boars (three Yorkshire x Duroc dams and one Hampshire sire) were included into the study. All boars were born in April 2000 and were slaughtered at the age of 33 weeks. Boars 1a and 1b, 2a and 2b, 3a and 3b were littermates. One group (1a, 2a and 3a) were raised indoors and the other group (1b, 2b and 3b) outdoors on a field with grass. All boars were provided with the same conventional diet. Blood samples were taken from all boars at the age of weeks 9 and 15, and thereafter at weekly intervals from the age of 20 weeks. Last blood samples were taken at slaughter at the age of 33 weeks. The boars were weighted at each sampling date. Skatole levels in plasma were measured with a modification of HPLC method developed by Claus et al. (1993). Skatole levels in plasma, which corresponded to rejection levels of skatole in fat, was calculated to be 12.6 μg/L in plasma. Total testosterone, estradiol-17β, DHEA sulphate and T_3 concentrations were measured using radioimmunoassay procedures (Diagnostic Products Corporation, Los Angeles, CA, USA), according to manufacturer's instructions. Estrone sulphate concentrations were analysed by double antibody enhanced luminescence immunoassay (Andersson et al., 1998). Hormone concentrations were standardised by using the equation $((x - \bar{x})/SD)$ in order to plot some of the figures using the same scale.

Results and discussion

The results from this study indicate a strong age effect on skatole levels in plasma in all pigs and also individual variations in skatole levels (Figure 1). Skatole levels were low in all boars at the age of 9 and 15 weeks. Then, skatole levels in boars from litter 1 increased at the age of 20 weeks and decreased at the age of 25 weeks, remaining below rejection level until the date of slaughter in boar 1b and increasing again at the age of 29 weeks in boar 1a. Skatole levels in boars from litter 2 increased rapidly at the age of 27 weeks and remained high until the date of slaughter. Boar 2b expressed highest maximum skatole concentration compared to other boars, 199 μg/L. This value corresponds to 13.6 ppm in fat, and surpasses the rejection levels more than 15 folds. Skatole levels in litter 3 were low until the age of 26 weeks. Then, the levels increased in boar 3a and remained rather stable until the date of slaughter. Skatole levels in boar 3b were low compared to the other boars and exceeded the cut off level at the age of 28, 32 and 33 weeks.

The usual slaughter weight of pigs in Sweden is 100–110 kg. Boars 1a and 1b reached live weights of 104 kg and 105 kg respectively at the age of 20 weeks, whereas other boars weighted 78 – 90 kg at this age. Increased skatole levels in litter 1 at this age might be related to the increased live weight. However, skatole levels in litters 2 and 3 at the age of 22 weeks, when the boars reached slaughter weight, were still low. The levels of sex hormones were also higher in the litter 1 at the age of 20–21 weeks compared to the hormone levels in the other litters. Concentrations of sex hormones in litters 2 and 3 increased at the age of 25–27 weeks, as did skatole levels. As both weight and sex hormones indicate the time of puberty onset, variations of skatole levels might be related to differences in the puberty stages in different boars. The lowest concentrations of the hormones were observed in boar 3b, which also had the lowest skatole levels throughout duration of the experiment. The highest concentrations of all hormones were observed in boar 1b.

Relationships between levels of skatole and sex hormone after the age of 20–21 weeks were similar within litters in spite of the fact that in each litter one of littermates were raised indoors and the other outdoors. However, relationships between skatole and hormone levels differed between litters. Fig. 2 and 3 indicate negative relationships between skatole and hormone levels in boars 1a and 1b. On the other hand, skatole levels in boars from litters 2 and 3 increased following the elevation of sex hormone levels. Fig. 4 illustrates a relationship between levels of skatole and sex hormones in boar 2b.

Variations of skatole levels in investigated boars can not be explained by changes of sex hormones concentrations. It might mean that skatole levels are not related to sex hormones production, suggesting involvement of a complex mechanism of regulation of skatole levels in boars. Possible interactions between different hormones need to be investigated.

Substantial changes in the concentrations of triidothyronine were observed from the age of 22–24 weeks until the slaughter date. Maximum concentrations of skatole coincided with increased T_3 levels in all boars. However, in some cases elevation of T_3

levels were not related to changes in skatole levels. Fig. 5 demonstrates relationship between levels of skatole and T_3 in boar 2a. Similar trends were observed for all boars.

Conclusions

Levels of skatole in plasma reached values above the rejection level in each boar but at different ages. The age related patterns of skatole levels were different between litters, but similar within litters. Two boars coming from one litter had high skatole levels at the slaughter age/weight, whereas other boars reached high skatole levels later. Skatole reached high levels earlier in boars with a relatively high live weight and high concentrations of sex hormones. Relationships between skatole and sex hormones levels might be described as positive or negative for the different litters. Increased levels of skatole were related to increased T_3 levels.

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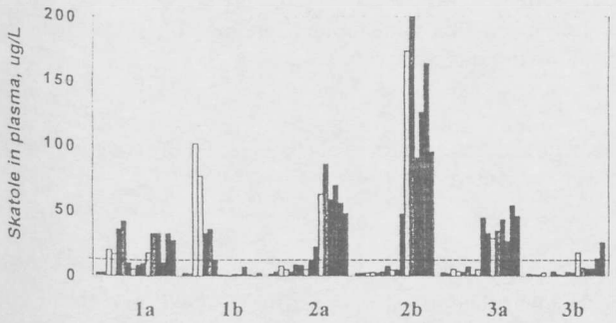

Figure 1. Skatole concentrations in plasma taken from 6 boars at different ages. Columns correspond to the different age of boars (9, 15, 20–33 weeks). Dashed line corresponds to 0.20 ppm of skatole level in fat.
Skatole levels in fat at slaughter (33 weeks) were: 1a, 0.24 ppm; 1b, 0.12 ppm; 2a, 0.58 ppm; 2b, 1.5 ppm; 3a, 0.53 ppm; 3b, 0.23 ppm.

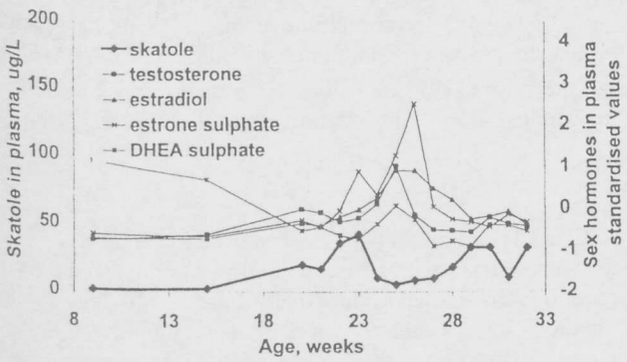

Figure 2. Relationship between skatole and sex hormones levels in boar 1a.

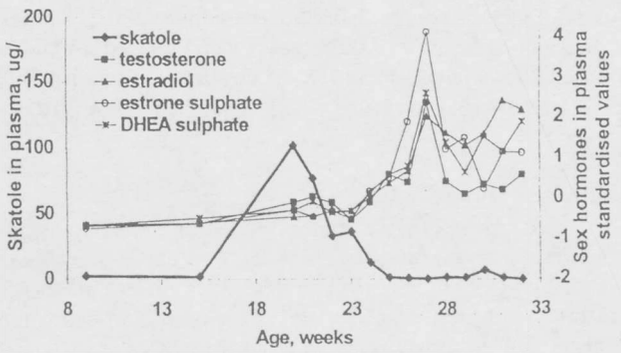

Figure 3. Relationship between skatole and sex hormones levels in boar 1b.

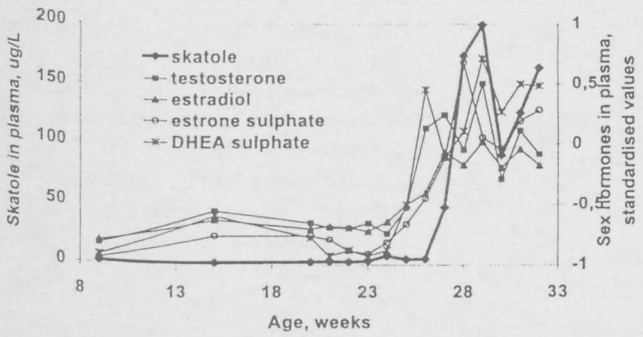

Figure 4. Relationship between skatole and sex hormone levels in boar 2b. (N.B. different scale for hormones)

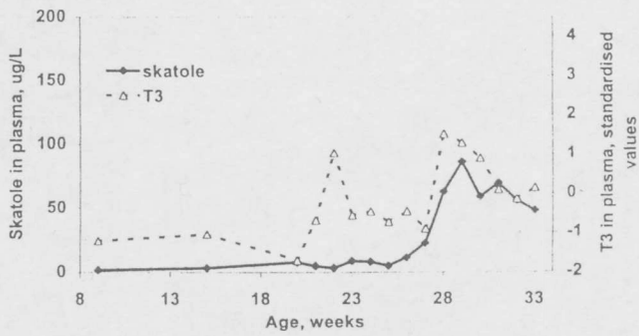

Figure 5. Relationship between skatole and T_3 levels in boar 2a.