The Causes and Control of Boar Taint Stefan Guizot Bsc Agric (Animal Science)

Introduction

The urgent need to expand global food production has focused the attention of the meat industry on methods of increasing output.

In recent years there has been increased interest in the production of meat from entire males. This is mainly due to the greater efficiency of feed conversion and the possibility of higher edible carcass yields. Rearing of boars rather than barrows would result in production of 8-10% more lean meat per pig and would increase feed efficiency by 12-15% (Pearson, unpublished data). Numerous studies on the effect of castration of male pigs have suggested that large economic advantages would result from the rearing of intact male pigs for meat production if the problem of boar taint could be circumvented (Walstra and Kroeske, 1968; Martin, 1969; Turton, 1969; Siers, 1975).

The origins of taint

Boar taint has been described as an unpleasant urine like or perspiration like odour released by boar meat during heating and is unacceptable to many consumers.

Although the chemical components responsible for boar odour are still under study, it is generally accepted that a family of 16 unsaturated steroids known as $C_{19}\,\Delta^{16}$ are responsible for the objectionable odour (Brooks and Pearson, 1986). The $C_{19}\,\Delta^{16}$ steroids are synthesized primarily in the testes of the boar and are released into the blood via the spermatic vein. Once released into the blood, $C_{19}\,\Delta^{16}$ steroids are transported to the adipose tissue and stored (Bonneau and Terqui, 1982). Storage of $C_{19}\,\Delta^{16}$ steroids in adipose tissue is reversible since 5α androst-16-en-3-one concentrations in adipose tissue decline in male pigs after castration (Claus, 1976).

The other main compound thought to contribute to boar taint is Skatole (3-methyl-indole), a compound possessing a strong faecal odour. Skatole is a metabolite formed during the breakdown of tryptophan by intestinal micro-organisms, and it's presence has been found to strengthen synergistically the unpleasant odour of 5α androst-16-en-3-one (Lndstrom et al, 1980). Both tryptophan from the diet and cell debris from the degradation of intestinal mucosa can be metabolised to skatole (Deslandes et al, 2001) .

Because the synthesis of the sex steroids and 16-androstenone steroids are closely related, the

production of estrogens and androstenone increase together and the androstenone accumulates in the fat. At the same time, the elevated levels of the sex steroids reduce the metabolism of skatole and the subsequent clearance from the body, resulting in increaed levels of skatole in the fat.

The relative contribution of these substances to boar taint varies in different studies. Other substances may also contribute to a minor degree and a range of substances with an off odour/off flavour has been identified in boar fat. (Garcia and Diaz, 1989). It must however be noted that whereas androstenones are hormonal compounds, skatole is a metabolite.

Factors affecting boar taint

There are a number of factors that are thought to contribute towards boar taint. These range from external factors, such as feed, management and environment, to intrinsic factors such as genetics. Results from research on the influence of diet on the levels of boar taint have produced varying results but a number of studies have indicated that diets high in crude fibre could increase the levels of skatole in pigs. As mentioned, skatole is formed in the digestive tract from tryptophan. This conversion is performed partly by a lactobacillus strain (Ykoyama and Carlson, 1979), and lactobacilli form an important part of the microflora in the hind gut of pigs (Rolanson et al, 1984). A low nutrient density diet with a high crude fibre content will stimulate the fermentative process in the hind gut (Just et al, 1983). This will lead to an increased number of bacteria in the colon and thus to larger quantities of microbial protein. Such protein is known to be of high biological value and can act as an extra source of tryptophan (Lundström et al, 1988).

Environmental influences are related to management and include stocking density, the cleanliness of the pens, slatted or solid floors and ventilation. All of these have been proved to influence the levels of skatole in all pigs, not only boars. In a study with female and castrated pigs, male pigs indicated that high stocking rates (0.6 m^2/pig) plus faeces and urine deposition in the pen may increase skatole concentrations in subcutaneous fat compared with clean pigs with a stocking rate of 0.8 m^2/pig. This increased skatole level was especially apparent in two summer experiments when the temperature was high in the pens (Hansen, Barton, Gade and Vorup, 1991). This experiment also indicated that the skatole concentration in subcutaneous fat decreased significantly when the pigs were kept clean from faeces for only a week.

The fact that a number of the male pigs with high skatole levels were closely related in a trial

conducted by Lundström et al (1988) suggests a genetic influence on skatole. The concentration of extremely high skatole levels in progeny groups derived from a few sires may be due to a single gene. It is unlikely that a dominant gene is involved, as the progeny of some sows mated with one of the sires giving high values, did not inherit high skatole levels, while other dams produced solely sons with high skatole values when mated with the same sire. It also seems likely that a triggering environment is needed for the gene to come to expression. A triggering environment could be for example a high stocking rate, high stable temperature (Hansen et al, 1992).

Control of boar taint

The five $C_{19}\,\Delta^{16}$ steroids believed to contribute to boar taint in pork are biosynthesized within the same metabolic pathways. Therefore auto-immunization of boars against production of the initial $C_{19}\,\Delta^{16}$ steroids in the pathway should theoretically prevent the biosynthesis of all other $C_{19}\,\Delta^{16}$ steroids. Recent studies have shown that vaccination of boars with a GnRH vaccine is effective in eliminating boar taint. Dunshea et al (2001) assessed the efficacy of a GnRH vaccine, Improvac, in eliminating boar taint. It was found that boar taint, as assessed by the concentration of androstenone and skatole in subcutaneous fat, was suppressed to low or undetectable levels in 100% of Improvac treated boars. Compared to with barrows, Improvac treated boars were leaner and had superior feed conversion efficiency.

Squires (2006) concluded that boar taint due to high levels of skatole and androstenone is highly heritable and not all market weight entire males have boar taint. It should thus be possible to select for pigs which do not have boar taint. A number of candidate genes for boar taint have been identified and work is continuing to develop genetic markers for low boar taint based on Single Nucleotide Polymorphisms (SNP's) in these genes.

It will be of undoubted value to identify and evaluate low cost methods of reducing boar taint that can be easily introduced into production systems. These methods may include reducing roughage in pig diets to reduce the presence of Lactobacillus bacteria in the gut of pigs, and cleaning pigs and pens of faeces at least a week before slaughter to reduce skatole levels.

Conclusion

The influence of boar taint on consumers acceptance of boar meat has received widespread attention and a great amount of research is being conducted into the control and / or elimination of boar taint in pork. Boar taint could, at the present time, be a greater problem in First World countries with well educated consumers who can afford to be selective about the type of meat it will eat. H.L de Kock et al studied the South African consumers reaction to boar odour. South Africa has several different demographic groups and pork consumption varies widely between these groups with whites eating 16.2kg per capita compared to blacks eating 0.6kg per capita It was found that all the consumers, regardless of demographic group, disliked the samples with high concentrations of skatole or high concentrations of a combination of skatole and androstenone. It is possible that the presence of boar taint in South African pork could be hampering the growth in consumption of pork and as such needs urgent attention