Androstenone and skatole levels in South African pigs as influenced by sex type, season, stocking density and diet

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Background: Boar production is a highly controversial topic in South Africa. Public utility abattoirs also accept entire boars for slaughter, thus do not subscribe to a non-castration policy, supported by producers who maintain that the rearing of entire males is more efficient than castrates regarding growth, feed utilisation and carcass yield. Private integrated abattoirs, owned and managed by processors, demand the castration of boars as they anticipate consumer resistance to boar taint which may be found in the meat of entire male pigs.

The compounds mainly responsible for boar taint are androstenone and skatole (Brooks & Pearson, 1986). The origin of these compounds is quite different - androstenone is an end product of the steroid metabolic pathway in the testis while skatole is formed by the degradation of tryptophan by intestinal micro-organisms (Brooks & Pearson, 1986). It has been estimated that these compounds, individually or in combination, account for 60 to 70 % of the variation in boar taint (Lundstrom *et al.*, 1980). The odour of "tainted meat" is not unique to boars as it is also detected at low levels in castrates and gilts; however, the incidence of boar taint was reported to be much higher for boars compared to castrates and gilts (Hansson *et al.*, 1980).

Boar taint thus is a complex problem that warrants attention as companies could suffer serious economic setbacks resulting from consumer resistance to tainted products.

Objectives: To investigate the boar taint phenomenon under South African conditions, with special emphasis on the effects of sex type, season, stocking density and diet on skatole and androstenone levels in the backfat of pigs.

Methods: The trials were done over two seasons - summer and winter. In each season, 120 pigs (60 boars, 30 gilts and 30 castrates), purchased from the same producer, were raised under commercial production conditions at stocking rates of 1.13, 0.82 and 0.65 m^2/pig. The different sexes were raised in separate pens. Boars were fed either a 16 % protein or a 18 % protein diet, while all gilts and castrates were fed on the 16 % protein diet. At 90 kg live mass the pigs were slaughtered and backfat samples (loin area) were taken and stored frozen until analysis. Indole, skatole and androstenone were determined by means of HPLC, using a C18-column (3.9 mm x 150 mm), isopropanol as extraction medium, and a water/acetonitrile/tetrahydrofuran solvent gradient (a modification of the method of Hansen-Moller & Andersen, 1994).

Results and discussion: The effects of sex type, season and stocking density on the occurrence of the main contributors to boar taint are summarised in Tables 1 and 2.

Table 1. Effect of season, sex type and stocking density on the occurrence of indole, skatole and androstenone in pigs.

Variable	Season (A)			Sex type (B)				Density (m^2/pig) (C)				AxB	AxC	BxC
	P value	Summer	Winter	P value	Boars	Gilts	Castrates	P value	1.13	0.82	0.65	P value	P value	P value
Indole	0.0012	0.014	0.001	0.0005	0.019	0.000	0.002	0.7233	0.010	0.001	0.001	0.0025	0.5392	0.7034
Skatole	0.0000	0.127	0.032	0.0002	0.146	0.044	0.048	0.9880	0.079	0.078	0.082	0.0211	0.8975	0.7421
Androstenone	0.0078	0.211	0.285	0.0000	0.511	0.110	0.122	0.4545	0.227	0.271	0.245	0.6743	0.9502	0.8789

Values other than the P-values are expressed as µg/g fat

Table 2: Indole, skatole and androstenone levels (µg/g fat) in pigs as influenced by season, sex type and stocking density

Variable	Summer			Winter		
	Boars	Gilts	Castrates	Boars	Gilts	Castrates
Indole	0.036 (3.4)*	0.003 (0.0)	0.004 (0.0)	0.002 (0.0)	0.000 (0.0)	0.000 (0.0)
Skatole	0.236 (31.0)*	0.063 (6.7)	0.081 (6.7)	0.056 (0.0)	0.025 (0.0)	0.014 (0.0)
Androstenone	0.461 (44.8 / 0.0)**	0.088 (0.0 / 0.0)	0.083 (0.0 / 0.0)	0.562 (36.7 / 13.3)	0.131 (0.0 / 0.0)	0.161 (0.0 / 0.0)

* Frequency (%) of indole/skatole ≥0.2 µg/g fat
** Frequency (%) of androstenone ≥0.5<1.0 / ≥1.0 µg/g fat

The skatole levels were found to be affected by season to a very high degree. The frequency of high skatole levels (≥0.20 µg/g) in the backfat of pigs ranged from 14.6 % of pigs reared in summer to none reared in winter. This tendency can possibly be attributed to a higher skatole load from faeces at high ambient temperatures. Mainly entire male pigs were affected by the incidence of skatole, the frequency in the summer trial being 31.0 % for males compared to 6.7 % each for gilts and castrates. It is evident that the skatole levels were much higher in summer for all sex groups, especially for boars. Androstenone levels were significantly higher in winter in all sex groups, the levels in boars being 4-5 times higher than those in gilts and castrates (Table 2). As expected, only boars showed unacceptable high androstenone levels (≥1.0 µg/g fat). The frequency of androstenone containing boars is 6.8 % and 47.5 % for levels ≥1.0 and ≥0.5 µg/g fat respectively.

Stocking density did not influence (P>0.05) either skatole or androstenone levels in the backfat of pigs (Table 1). The effects of season, diet and stocking density on the occurrence of indole, skatole and androstenone in entire male pigs is shown in Tables 3 and 4.

Table 3. Effect of season, diet and stocking density on the occurrence of indole, skatole and androstenone in entire male pigs

Variable	Season (A)			Diet (B)			Density (m^2/pig) (C)				AxB	AxC	BxC
	P level	Summer	Winter	P level	16 %	18 %	P level	1.13	0.82	0.65	P level	P level	P level
Indole	0.0016	0.043	0.005	0.4151	0.019	0.029	0.9099	0.021	0.024	0.027	0.6356	0.8012	0.4662
Skatole	0.0019	0.271	0.078	0.3638	0.146	0.203	0.7554	0.140	0.189	0.195	0.7801	0.6604	0.3707
Androstenone	0.7951	0.587	0.610	0.0471	0.510	0.686	0.7731	0.600	0.632	0.563	0.3967	0.2481	0.6651

Values other than the P-values are expressed as µg/g fat

Table 4: Indole, skatole and androstenone levels (µg/g fat) in entire male pigs as influenced by season, diet and stocking density

Variable	Summer		Winter	
	16 % Protein diet	18 % Protein. diet	16 % Protein diet	18 % Protein diet
Indole	0.035 (1.7)*	0.050 (1.7)	0.003 (0.0)	0.007 (0.0)
Skatole	0.235 (15.3)*	0.308 (18.3)	0.058 (0.0)	0.098 (1.7)
Androstenone	0.462 (22.0 / 0.0)**	0.711 (13.6 / 10.2)	0.559 (18.3 / 6.7)	0.661 (21.7 / 8.3)

* Frequency (%) of indole/skatole ≥0.2 µg/g fat
** Frequency (%) of androstenone ≥0.5<1.0 / ≥1.0 µg/g fat

The nutrient composition of the feed boars were raised on had a significant effect (P≤0.05) on the accumulation of androstenone in the fat of boars, the 18 % protein diet causing on average higher androstenone levels than the 16 % protein diet. This is possibly a result of accellerated puberty due to faster growth of pigs fed the higher protein diet. The overall frequency of entire male pigs producing androstenone levels higher than 1.0 µg/g fat was 18.3 % for boars fed the 18 % protein diet compared to 6.8 % for those fed the 16 % protein diet.

No significant effect of nutrient composition was found on indole or skatole levels in boars. This is contrary to the findings of Lundstrom *et al.* (1988), who found higher levels of skatole in boars fed a lower nutrient-density diet. However, the increase in skatole levels the Danes observed, was probably due to the higher fibre content of the low-density diet compared to that of the high-density diet. There was little difference in the fibre contents of the feeds used in this study (3.65 and 3.09 % for the 16 and 18 % protein diets respectively).

The effect of season and stocking density on the skatole and androstenone levels in boars showed results similar to those described previously in this paper. No significant interactions were found between diet, season and stocking density.

Conclusions:

The incidence of high skatole levels (≥0.2 µg/g fat) in pigs is affected by season to a very high degree, with higher levels being produced in the summer season. Both skatole and androstenone levels are high in boars compared to gilts and castrates, which confirm suggestions by researchers that the skatole phenomena is, like androstenone, mainly a boar-related problem. Nutrient composition of the feed influences the accumulation of androstenone in the fat of boars - higher nutrient-dense diets (higher protein levels) cause on average higher androstenone levels. The accumulation of skatole in the fat of pigs is not affected by nutrient-density (protein contents) of a diet. Stocking density does not have significant influences on the incidence of skatole and androstenone levels in pigs.

References:

Brooks, R.I. & Pearson, A.M., 1986. Steroid hormone pathways in the pig, with special emphasis on boar odour: a review. *J. Anim. Sci.* 62, 632-645.

Hansen-Moller, J. & Anderson, J.R., 1995. Boar taint - analytical alternatives. *Fleischwirtsch.* 74, 963-966.

Hansson, K.E.; Lundstrom, K., Fjelkner-Modig, S. & Persson, J., 1980. The importance of androstenone and skatole for boar taint. *Swedish J. Agric. Res.* 10,167-173.

Lundstrom, K., Malmfors, B., Malmfors, G., Stern, S., Petersson, H., Mortensen, A.B. & Sorensen, S.E., 1988. Skatole, androstenone and taint in boars fed two different diets. *Livestock Prod. Sci.* 18, 55-67.