CARCASS COMPOSITION, MUSCLE QUALITY, ODOR INCIDENCE AND UTILIZATION OF BOAR MEAT

M.D. Judge[1], E.W. Mills[1], M.W. Orcutt[1], I.C. Peng[2], J.C. Forrest[1], M.A. Diekman[1], B.G. Harmon[1], R.S. Lin[1] and L.L. Nicholls[3], [1]Department of Animal Sciences, Purdue University, W. Lafayette, IN, 47907 USA, [2]Department of Food Science, Purdue University, W. Lafayette, IN, 47907 USA, [3]Department of Animal Science, University of Alberta, Edmonton, Alberta T6G2P5 CAN

SUMMARY

Carcasses and/or tissues of boars and barrows were analyzed for lean content, muscle quality, incidence of objectionable odor, 5a-androstenone concentration, skatole concentration and oxidative stability. Boars and barrows had different ($P < .01$) warm carcass weight (73.5 vs 80.1 kg), longissimus muscle area (36.0 vs 35.0 cm^2), fat depth (1.80 vs 2.57 cm), estimated percent muscle (56.1 vs 51.3%) and marbling score (1.73 vs 1.97). No difference ($P < .05$) was found for muscle color score (2.51 vs 2.45). While odor panel scores were higher ($P < .01$) for boars than barrows (1.74 vs 1.56), both were quite low, and the correlation coefficients between panel scores and 5a-androstenone content (.13) and between panel scores and skatole content (-.14) were nonsignificant ($P < .05$). Thiobarbituric acid values were lower ($P < .01$) in prerigor cooked samples (.25) than in reheated samples (.58) after frozen storage (-40°C) for 1 month, but were well below the threshold for sensory detection of rancid flavor.

INTRODUCTION

Boar meat is produced and merchandised successfully in some countries but the practice has not been widely tested or adopted in the USA (Malmfors and Lundstrom 1983). Objectionable odor in boar meat has been attributed to the C_{19}-D^{16} steroids, androstenone and androstenol, to the tryptophan degradation product, skatole, or to an interaction of the two types of materials (Lundstrom et al. 1980; Brennan et al. 1986). Lundstrom et al. (1980) reported that skatole enhances the sensory impression of boar odor as produced by androstenone.

Animal growth factors that influence expression of boar odor are numerous but inconsistent in their apparent effects (Brooks and Pearson, 1986). Although fat concentrations of C_{19}-D^{16} steroids may be relatively high in young boars (100 kg), Brennan et al. (1986) reported that 100-kg-live weight boars have only slightly higher odor intensity scores than gilts but the scores increase markedly in 130-kg boars. Accordingly, a weight- or age-associated factor may enhance the odor producing capacity of compounds such as androstenone. Since skatole is a product of microbial fermentation, it is possible that increasing quantities are produced with expansion of the digestive tract. Brennan et al. (1986) reported that boars which are restricted in feed intake from 100 to 130 kg live weight are older at slaughter but have similar or lower concentration of androstenol, androstenone and odor intensity to those fed ad libitum to 130 kg. Further research is needed on means by which digestive fermentation may be controlled in growing boars without impairment of growth performance.

Another potential control point for boar odor exists at the time of slaughter. Andresen (1975) developed a radioimmunoassay for 5α-androstenone and Desmoulin et al. (1982) established a threshold level of the hormone in fat of 0.5 μg/g for expression of undesirable odor in fresh meat. Danish workers (Mortensen and Sorensen 1984) suggested that 0.24 ppm of skatole may be used as a rejection level for boar odor. Further work is needed to establish screening tests for either or both of these materials.

The incidence of odor detection in boar meat by consumers varies widely. Highly processed pork products have a lower incidence of rejection than fresh pork and the odors are most prevalent during cooking (Malmfors and Lundstrom 1983). Consequently, utilization of boar meat for preparation of precooked products may offer another means to control or eliminate odor problems. Research is required to determine the feasibility of precooking boar meat to eliminate offensive odor but protect it from other palatability problems such as oxidative rancidity.

The objectives of this research were to 1) evaluate the carcass composition, muscle quality and odor incidence in group-reared boars receiving energy-dense diets, 2) determine the concentrations of 5α-androstenone and skatole in boar fat and their relationships with odor intensity and 3) determine the extent of lipid oxidation in boar meat after prerigor cooking and after subsequent storage and reheating.

EXPERIMENTAL METHODS

Yorkshire-Landrace-Duroc crossbred boars (510) and barrows (510) with mean weights of 24.4 and 24.0 kg respectively were penned in groups of 28 and fed a diet containing approximately 8% added animal fat. They were slaughtered in commercial facilities at 170-172 days of age and carcasses were weighed within 45 min postmortem. At 8-12 h postmortem, the left carcass sides were sectioned at the 10-11th rib space and tracings of longissimus muscle area and subcutaneous fat were made on acetate paper. Longissimus muscle area was determined with a grid and fat depth was measured at a

TABLE 1. Carcass composition, muscle quality scores and odor intensity scores for boars and barrows.

	Boars		Barrows	SE
Warm Carcass wt (kg)	73.5	**	80.1	.4
Longissimus area (cm^2)	36.0	**	35.0	.26
Fat depth[a] (cm)	1.80	**	2.57	.03
Estimated muscle[b] (%)	56.1	**	51.3	.13
Muscle color score[c]	2.51	NS	2.45	.03
Marbling score[d]	1.73	**	1.97	.03
Odor intensity score[e]	1.74	**	1.56	<.01
Number of animals	510		510	

[a]10th rib, 3/4 of the length of longissimus cross-section.
[b]% muscle = (4.92 + .42 x carcass wt, kg + .32 x longissimus area, cm^2 - 3.36 x fat depth, cm)/carcass wt, kg.
[c]1 = pale, soft, exudative; 3 = normal; 5 = dark, firm, dry.
[d]1 = traces, 3 = small; 5 = abundant.
[e]1 = no odor, 2 = very slight odor, 6 = strong odor.

Table 2. Thiobarbituric acid values for prerigor cooked boar muscles (n=24).

Sampling time	TBA value	SE
After cooking[a]	.25	.03
After reheating[b]	.58 **	.03

[a]45-60 min post exsanguination
[b]1 mo frozen storage, thawing, microwave heating
**P<.01

point that corresponds to 3/4 of the length of the longissimus cross section beginning at the medial border. Color-firmness-structure scores (1 = pale, soft, exudative; 3 = normal; 5 = dark, firm, dry) and marbling scores (1 = traces, 3 = small, 5 = abundant) were derived by two trained people. Samples of backfat (100g) were obtained at the 10th rib and frozen at -40°C for later analyses.

Backfat samples were thawed at 4°C for 24 h prior to odor evaluation. Samples weighing approximately 2 g were placed in capped 20 ml scintillation vials and heated on a hot tray at 100°C. The odor intensity of each sample was scored by a panel of eight women selected for their ability to detect androstenone. The odor intensity of all boars and barrow samples was scored on a scale of 1 to 6 (1 = no boar odor, 2 = very slight odor, 3 = slight odor, 4 = moderate odor, 5 = strong odor, 6 = very strong odor). Panelists evaluated up to 12 samples per day (6 boar, 6 barrow). The order of presentation of samples within each set was randomized for each panelist. A reference sample of 4 lg of 5α-androst-16-en-3-one was provided.

A subset of 46 backfat samples was randomly drawn from the boar samples and assayed for 5α-androstenone by radioimmunoassay as developed by Andresen (1974) and for skatole as described by Peleran and Bories (1985). Recovery rate of tritiated 5α-androstenone added to backfat samples was 95±2% and for skatole was 52±1%. Sensitivity of the hormone assay was 50 pg and the intrassay coefficient of variation was 12.1%. HPLC was used for quantitation of skatole. A Waters model 45 solvent delivery system with model U6K injector was coupled to a Lichrosorb RP-18, 10 lm (4.6 x 250 mm) column. The mobile phase was methanol and water (60:40) at a flow rate of 1.5 ml/min. An Isco absorbance detector was used at 225 nm wavelength.

Twenty-four additional boars of similar breeding to those described above were reared individually and slaughtered at approximately 150 days of age. One psoas major muscle from each carcass was removed within 45 min of exsanguination and heated in dry air at 300°C to an internal temperature of approximately 60°C. Thiobarbituric acid (TBA) values were determined as reported by Tarladgis et al. (1960). Sample portions were frozen at -40°C, stored for 1 month, thawed, reheated in a microwave oven and reanalyzed for TBA values.

Boar-barrow comparisons for carcass composition, muscle quality and odor intensity as well as time comparisons for TBA values were made by analysis of variance. Androstenone assays, skatole assays and odor intensity scores for the 46 sample subset were analyzed by correlation methods (Harvey 1975).

RESULTS

The production system used in this study (group reared on high-fat diets) produced boars whose carcasses were lighter (P < .01) in weight than those of barrows (Table 1). In spite of that, the boars produced the same weight of muscle per day of age (0.243 kg) as barrows (0.238 kg). These estimates are based on the regression equation derived by Forrest et al. (1988):

% muscle = (4.92 + .42 x carcass wt, kg + .32 xlongissimus area, cm^2 - 3.36 x fat depth, cm)/carcass wt, kg. x 100

Boars also were more efficient converters of feed to live weight than barrows, producing feed efficiency ratios of 3.45 and 3.54 respectively.

Muscle color scores were similar (P < .05) for boar and barrow carcasses but marbling scores were higher (P < .01) in barrows (Table 1). Backfat from boars had higher (P < .01) scores for odor intensity than that from barrows but both were relatively low.

Analyses of 5α-androstenone in 46 backfat samples revealed a mean value of 1.51 (±1.04 SD) μg/g. The correlation coefficient between androstenone and odor intensity score (0.13) was nonsignificant (P < .05). Skatole analyses gave a mean value of .37 (±.20 SD) μg/g. Correlation coefficients for skatole vs. androstenone (-.02) and vs. odor intensity score (-.14) were nonsignificant (P < .05).

TBA tests for lipid oxidation in prerigor cooked psoas major muscles of boar carcasses produced values that were very low (.25), then rose (.58) (P < .01) after 1 month of frozen storage and subsequent reheating (Table 2).

DISCUSSION

This study demonstrates that boars may be reared in USA production facilities and will produce muscle as rapidly and more efficiently than barrows. Further, they can utilize high-fat diets (approximately 8% added fat). Boars reared under described conditions were typical in muscle color and marbling as reported by other workers (Malmfors and Nilsson 1978). However, odor intensity scores were lower than those previously reported for similar weight animals on which the same type of sensory panel and scoring system were used (Brennan et al., 1986). The scores averaged slightly below the "very slight odor" range on our scale, whereas, the boar meat evaluated by Lundstrom et al. (1980) scored most frequently in the "obvious boar taint" range of their scale. It is not possible to identify the cause(s) of the relatively low levels of odor in these boars but the high-fat diet could have been influential. Energy-rich low-fiber diets could limit skatole production from bacterial degradation of tryptophan in the hind gut or could inhibit physical expansion of the digestive tract.

In contrast to lower than expected odor intensity scores, 5a-androstenone concentrations in backfat were higher than the reported threshold for detection of odor by consumers (Desmoulin et al., 1982). This supports the view that androstenone expression as boar odor may be dependent on an interaction with other compounds such as skatole (Lundstrom et al., 1980). With this theory, when skatole concentration is low, the correlation of androstenone concentration with odor intensity scores would be low or nonexistent as found in this study. On

the other hand, skatole concentration was higher than that reported by Lundstrom et al. (1980) but different analytical methods were used. There is insufficient literature on skatole concentration as determined by HPLC to compare our results with other skatole assays. Nevertheless, the poor correlation between skatole and odor intensity score suggests that skatole is not always a dependable indicator of boar odor.

TBA values for prerigor cooked boar muscles were well below threshold levels for sensory detection of oxidative rancidity. Even after 1 month of frozen storage, thawing and microwave reheating, TBA values were relatively low. Although heating and reheating in the absence of antioxidants are associated with enhanced lipid oxidation, the high pH of prerigor meat limits oxidation (Yasosky et al. 1984). Successful avoidance of warmed-over-flavor would enable processors to precook boar meat and allow offensive odor compounds to escape before contact with consumers.

CONCLUSIONS

Boars reared in USA production facilities and fed high-fat diets produce meat with a low incidence of offensive odor. Concentration of 5α-androstenone and skatole in backfat are unrelated to odor intensity under these conditions. Precooking of boar meat may allow offensive odors to escape without initiation of lipid oxidation if accomplished in the prerigor state.

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