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Pork quality of male hybrids from Lithuanian Wattle pigs and wild boar intercross

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Abstract. The aim of this study was to compare the quality of meat from hybrid (Lithuanian indigenous wattle pigs x wild boar intercross) intact and castrated males. A total of 39 intact and castrated male hybrids from 1/4 and 1/2 wild boar genotype were included in the study. The hybrids from 1/4 wild boar genotype had lower eye loin area ($P<0.05$) and carcass cooling loss ($P<0.001$) than those from 1/2 wild boar genotype. Intact boars had lower carcass dressing percentage ($P<0.05$), backfat thickness ($P<0.001$) and higher loin area ($P<0.001$) than castrates. No differences were found as regards technological meat quality, but the taste panel study showed higher acceptability of pork from 1/4 wild boar genotype and castrates than that from 1/2 wild boar genotype and intact boars. A significant correlation was found between the age of intact boars and odour and juiciness ($P<0.05$). The concentration of testosterone in plasma was correlated with pork and fat odour.
Key words: swine, meat, taste panel, Lithuanian Wattle, wild boar.

INTRODUCTION

Wild boar meat is attractive for its intense, sweet and nutty flavour. There is a growing interest in the production and marketing of wild boar meat and in different countries farms have been established specifically for its production (Gongora et al., 2003). The population of wild boar is limited and some meat may be derived from wild boar and domestic pig crosses. The current interest in the hybrids of Lithuanian indigenous wattle pigs and wild boar intercross originates largely from the search for the possibilities of adaptation of conserved Lithuanian indigenous pigs to production niches designed for specific quality products. If the wild boar is to contribute to commercial pig genotypes, then an increasing importance is being placed upon the eating quality of intact male hybrids. The rearing of domestic intact male pigs is avoided in most countries because of its association with boar taint (Malmfors & Lundström, 1983; Bonneau et al.,1992; Bonneau et al., 2000; Matthews et al., 2000; Aldal,et al. 2005; Fredriksen et al.,2006). Castration of male piglets is a controversial issue within Europe, mainly from the perspective of animal welfare (EFSA, 2004). From 2009, castration of intact male piglets will be prohibited in Norway (Andersson et al., 2005; Fredriksen et al., 2006). It is recognised that the risks associated with castration of young males of domestic pigs are minimal but the surgical castration of

wild boar is unknown and is not even under consideration, therefore the castration of their hybrids is questionable, as well. The impact of intact males from Lithuanian indigenous and wild boar intercross is unclear and this study was, therefore, set up to compare the eating and technological meat quality from 1/4 and1/2 wild boar genotype intact and castrated males reared under farm production conditions.

MATERIALS AND METHODS

Animals and slaughter procedures

The thirty-nine animals used were intact and castrated male hybrids from Lithuanian indigenous wattle x wild boar intercross (1/2 WB genotype) and their backcross (Lithuanian indigenous wattle x wild boar) x: Lithuanian indigenous wattle (1/4 WB genotype). The study included material from nineteen 1/4WB and twenty 1/2WB genotype hybrids. The hybrids were born in the piggery of the Institute of Animal Science of the Lithuanian Veterinary Academy. Fifteen males from both groups were castrated at two weeks of age. The hybrids were reared indoors in mixed-gender groups from birth to slaughter consuming twice a day the same standard concentrate feed, containing 12.2 MJ metabolisable energy and 14.5% crude protein balanced with lysine (0.78%/kg feed). The basal diet was supplemented by a small amount of grass in summer and beet and apples in autumn**.** Animals were slaughtered when they reached approximately 90 kg weight**.** The slaughtering was conducted in the abattoir for control slaughtering of the state pig breeding station after 5 km transportation immediately prior to slaughter with minimum handling stress. Pigs were stunned with electricity and were bled within 15 s of stunning. Afterwards, the carcasses were scalded in a Hubert H_{AAS} scalder for 5 min. at 64^0C and dehaired. Testes from intact boars were removed immediately after scalding and weighted. The head was removed and the carcass was split longitudinally on the midline.

Carcass evaluation and sampling

Eviscerated carcasses were weighed to determine warm carcass weight and chilled for 24 h at +2-4^0C. Carcass weight was measured without head and feet. Dressing percentage was calculated as percentage of carcass weight 1 h after slaughtering on live weight before slaughter. After twenty-four hours post-mortem, carcasses were weighed again to determine cold carcass weight. Cooling loss was calculated as difference between warm and cold carcass weight in percentages. Measurements of backfat thickness were taken with a ruler on the left side of carcasses at the dorsal line of mid back at the last rib. The photo was taken to measure the area of *M. longissimus dorsi* at 1/2 lumbar vertebra by digital camera EX-Z110 (Casio) Afterward, the loin area was planimetrically measured by means of the "SCAN-STAR K" planimetrical system (Germany) (Razmaitė et al., 2008). Samples of *M. longissimus dorsi* (LD) were collected from the loin of the left side of carcasses. To analyse technological meat quality the samples of the posterior part of LD were taken at 1-2 lumbar vertebra. Samples from l-2 lumbar vertebra and fore-part of LD for sensory evaluation were placed in a refrigerator at 4ºC until the test panel trial was conducted. Samples of *M. semimembranosus (SM)* were collected from the ham of the left side of carcasses and frozen for 5 days at -20ºC.

Table 1. Carcass–related traits by genotype and gender of male hybrids and their interactions

	Genotype			Gender			Interactions			
	1/4 WB	1/2 WB	SED	Entire boars	Castrates	SED	1/4 WB genotype x gender	1/2 WB genotype x gender	1/4 WB entire boars x 1/2 WB entire boars	1/4 WB castrates x 1/2 WB castrates
Age, days	229.3	282.1	9.71***	249.3	256.4	13.29	*ns*	*ns*	***	***
Live weight, kg	88.1	90.5	1.02	89.5	89.1	1.12	*ns*	*ns*	*ns*	*
Carcass weight, kg	59.0	59.4	1.00	58.3	59.8	0.99	*ns*	*	*ns*	*ns*
Dressing percentage, %	67.0	65.6	0.76	65.1	67.1	0.74*	*ns*	*	*ns*	*ns*
Chilled carcass weight, kg	57.9	56.6	0.31	55.9	58.2	1.22	*ns*	*	*ns*	*ns*
Cooling loss, %	1.8	4.7	0.67***	4.1	2.7	0.82	*ns*	*	*ns*	*ns*
Backfat thickness of mid back at the last rib, mm	25.1	27.9	1.85	21.8	28.8	1.60***	**	***	*ns*	**
Loin area, cm^2	26.8	30.0	1.22	31.4	26.5	1.12***	*	*ns*	*ns*	*ns*
Testosterone, nmol/l	134.2	103.7	50.25	113.9	-	-	-	-	*ns*	-

Significance levels: *P<0.05; **P<0.01; ***P<0.001; *ns* – not significant
SED-standard error of difference

Plasma collection and testosterone analysis

Blood samples of intact boars were taken from the vein *cava cranialis* at slaughter. Blood samples were collected in 10 ml tubes containing heparin. After collection, blood samples were refrigerated at 4ºC for approximately 6 h and then centrifuged for 5 min at 2000 rpm. Plasma samples were stored at -20^0 C until they were assayed for testosterone concentration. Testosterone (17β-hydroxyandrostenone) concentration was measured by electrochemiluminescence immunoassay using Elecsys 1010 analyzer and reagents (Roche Diagnostics GmbH, Manheim, Germany). Elecsys testosterone is based on a competitive test principle using monoclonal antibody specifically based against testosterone. The test has been calibrated by using ID-GC/MS (Isotope Dilution Gas Chromatography Mass Spectrometry). Samples were diluted 1:10 before measuring by using 0.9% sodium chloride solution.

Technological meat quality

Technological meat quality was determined approximately 24 h post mortem. Meat pH was measured by using Knick pH-766 meter (CALIMATIC, Berlin, Germany). Colour intensity was determined by the method of Khornsi's modification with a spectrophotometer СФ-46 (LOMO, Russia), as described in the methodological guidelines (Misik, 1978). Cooking loss was found according to meat weight differences before and after cooking. Water holding capacity of LD was determined by the method of Grau and Hamm (1953). The water holding capacity as thawing loss of SM was determined as weight difference of frozen and defrosted SM (Heyer et al., 2004).

Sensory panel evaluation

After 48 h post mortem, the samples of LD were cooked in boiling water at water and meat ratio 3:1 with sodium chloride addition of 1% meat weight for 1 h, and served to a taste panel and evaluated using subjective scoring scales, suggested in the methodological guideline (Pocherniajev et al, 1977). Lean meat samples were scored according to pork odour (1 = unacceptable to 9 = extremely good and strong), flavour (1 = extremely bad (unacceptable) to 9 = extremely good (fine), tenderness (1 = extremely tough to 9 = extremely tender), juiciness (1 = extremely dry to 9 = extremely juicy) and calculated overall score taking into account all features. Samples of fat were assessed for pork odour (1=extremely weak to 9 = extremely strong), abnormal odour (1= no abnormal to 9 = extremely strong) and boar taint intensity (1= none to 4 = pronounced) as described by Ellis et al. (1995). The taste panel comprised 9 individuals (five females and four males) who were selected on the basis of their ability to discern differences in the organoleptic properties. A total of 5 panel sessions were convened with three to five samples being evaluated at each session. The average number of panellists attending each session was 8 with the minimum involved in any session being seven. Samples were allocated from both groups such that each session comprised a minimum of one sample from a castrated male and at least one and no more than 4 samples from intact males. Before panel sessions panellists were trained to recognize androstenone in samples using a synthetic androstenone (5α-androst-16-en-3-one).

Statistical analysis

Statistical analysis was performed with the General Linear Model (GLM) procedure in MINITAB release 14.20. The model included genotype (1/4WB or 1/2WB) and gender (intact boars or castrates) as fixed factors for carcass-related and meat quality traits.

$$y_{ijk} = \mu + genotype_i + gender_j + e_{ijk}$$

where: $genotype_i$ – 1/4WB or 1/2WB genotype; $gender_j$ – intact boars or castrates; e_{ijk} – residual error.

For statistical analyses of sensory meat quality, additionally taste panel members and individual animals were included in the model as random factors.

$$y_{ijkln} = \mu + genotype_i + gender_j + taste\_panel\_member_k + animal_l + e_{ijkln}$$

where: $genotype_i$ – 1/4WB or 1/2WB genotype; $gender_j$ – intact boars or castrates; $taste\_panel\_member_k$ – effect of taster; $animal_l$ – effect of individual animal; e_{ijkln} – residual error.

Tukey`s HSD significance test (α=5%) was used to ascertain the existence of significant differences between the traits and where they occurred. The effect of factors (genotype, gender, taster and animal) on the analysed traits was estimated by multi-way analysis of variance (ANOVA). Pairwise correlation (Pearson`s correlation coefficients) was calculated.

RESULTS AND DISCUSSION

Growth and puberty

Live weight at slaughter in the subgroups were similar, with the largest difference of 2.4 kg (P<0.05) between 1/4 WB (88.1 kg) and 1/2 WB (90.5 kg) genotypes (Table 1), but the age at slaughter of 1/2 WB genotype group was 52.8 days (P<0.001) higher compared with 1/4 WB genotype. Marklund et al. (1999) reported that the progeny who had received a wild boar chromosome segment were associated with reduced growth. Moreover, the average growth rate differs markedly between the generations with different proportions of wild boar. Hybrids in our study had an average proportion of wild boar of 25 and 50%. Consequently, the age at slaughter in this study differed significantly between the 1/4 and 1/2 WB genotypes. Wild boar introgression is associated with reduced carcass weight, increased *longissimus* muscle area and higher fat deposition (Andersson-Eklund et al., 1998; Marklund et al., 1999). Of the WB genotype pigs, 1/4 had a higher dressing percentage, concentration of testosterone and lower backfat thickness than 1/2 WB genotype pigs, but all these differences were statistically insignificant. Higher concentration of testosterone in 1/4 WB genotype boars coincide with the findings of Sellier et al. (2000); Bender et al.(2006) who estimated that higher concentration of androgens is associated with higher growth performance and age at puberty.

Carcass traits and technological meat quality

The 1/4 WB genotype hybrid pigs had smaller loin eye areas (P<0.05) and carcass cooling loss (P<0.001) than 1/2 WB genotype hybrids. Müller et al. (2000) have reported that carcass cooling loss was higher in wild boar than in Meishan and Pietrain and differed largely in the F_1 and F_2 generations; these results are consistent with our

study. Intact boars had lower dressing percentage (P<0.05), backfat thickness (P<0.001) and higher loin eye area (P<0.001) than castrates. Intact boars also tended (P=0.08) to have higher carcass cooling loss. These results were not unexpected, because they coincide with the findings reported by Barton-Gade (1987); Babol and Squires (1995); Nold et al. (1997); Suster et al. (2006). The1/4 WB genotype x gender significant interactions were observed only for backfat thickness (P<0.010) and loin eye area (P<0.05) showed that intact boars had lower backfat thickness and higher loin area than castrates. The 1/2 WB genotype x gender significant interactions were observed for most carcass-related traits, except for live weight, age and loin eye area (Table 1). Marchiori and de Felicio (2003) have reported that wild boar meat has advantages over pork for more intense red coloration, lower exudates losses, and slower decline in pH but in our study there were no statistically significant effects of genotype and gender on technological meat quality and there were no genotype x gender interactions for meat quality (Table 2). Andersson et al. (2003) also found no gender differences between intact boars and castrates for technological meat quality.

Table 2. Technological meat quality of muscles from male hybrids (P>0.05)

	Genotype		SED	Gender		SED
	1/4 WB	1/2 WB		Entire boars	Castrates	
pH_{LD}	5.46	5.53	0.09	5.59	5.44	0.09
Colour	65.0	74.7	6.94	69.9	69.6	7.26
Water holding capacity $_{LD}$, %	61.5	62.0	1.11	61.3	62.1	1.11
Thawing loss $_{SM}$, %	5.7	7.1	2.28	6.5	6.7	1.27
Cooking loss $_{LD,}$ %	40.4	39.9	1.65	38.8	41.0	1.64

SED-standard error of difference

Sensory evaluation of pork and fat

The results of the taste panel study showed that the acceptability of pork from 1/4 WB was higher. Samples of LD from 1/4 WB genotype had higher scores in pork odour (P<0.001), tenderness (P<0.01) than from 1/2 WB genotype group (Table 3). The taste panellists' findings showed a preference for meat from 1/4 WB genotypes can be explained by 1) the rare and low consumption of wild boar in Lithuania, and 2) insignificant but lower intramuscular fat content. However, the results reported by Blanchard et al. (2000) do not support the belief that fatness level per se has a major influence on pork eating quality. Samples of backfat from the 1/2 WB genotype had a higher incidence of abnormal odours (P<0.01) and boar taint intensity (P<0.05). There were significant effects of gender (P<0.001) to the pork odour and flavour, where meat produced from castrates was judged to be better than that from intact boars. Samples of

LD from intact boars were tender ($P<0.05$) but samples of backfat had a higher boar taint intensity than those from castrates. Weiler et al. (2000) have reported on considerable variations between human populations with regard to the sensitivity of boar taint. However, these findings are similar to those observed in earlier studies using different breeds or genetic lines (Babol et al, 1995; Ellis et al., 1995; Nold et al, 1997; Dijksterhuis et al., 2000; Bañón et al., 2004) but they are in contrast with those of Wood et al (1995) who did not find any evidence of difference in eating quality between intact males and females. There were no statistically significant effects of gender on other abnormal odours of backfat. The 1/4 WB genotype x gender interactions were observed only for boar taint intensity ($P<0.05$). Gender x 1/2 WB genotype interactions were observed for pork odour ($P<0.001$), tenderness ($P<0.05$) and boar taint intensity ($P<0.001$). Significant interactions between intact boars of different genotypes observed for pork odour ($P<0.001$) and flavour ($P<0.01$) showed that 1/4 WB intact boars had higher scores. Significant interactions between the castrates of different genotypes were observed only for juiciness ($P<0.01$). Generally, hybrids of the 1/4 WB genotype from both groups had higher scores than hybrids of the 1/2 WB genotype.

Relationship between sensory attributes and growth and puberty parameters

Differences in sensory evaluation of boar taint and genotype may be due to differing rates of sexual maturation. Pearson's correlation coefficients were additionally used for intact boars as an exploratory tool to ascertain significant associations of age, weight, weight of testes and concentration of testosterone with any one sensory response. Obtained correlation coefficients for sensory attributes of pork were fairly low despite the significance found for the correlation between the age of intact boars and odour and juiciness ($P<0.05$) in the samples of LD and the correlation between pork odour, abnormal fat odour and the concentration of testosterone (Table 4). This is in contrast with the findings of Squires et al. (1991) who did not find significant correlations between sensory attributes and the levels of testosterone in the blood, but recently a significant correlation between testosterone and boar taint compound androstenone has been found (Babol et al. 1999, Zamaratskaia et al. 2004 a, b). Despite high correlation of testosterone and androstenone in plasma, correlations between testosterone and androstenone in fat and microsomal metabolites of androstenone were insignificant (Babol el al. 1999).

Variation analysis of sensory evaluation data showed that the animal itself had the highest (from 7.7% to 84.5%) impact on the evaluation of pork sensory properties. The influence of gender on different sensory properties differed from 0.3% to17.8% and the influence of genotype ranged from 0.5% to 12.7%.

Table 3. Taste panel evaluation by genotype and gender for eating quality scores of fresh *M. longissimus dorsi* and backfat

	Genotype			Gender			Interactions			
	1/4 WB	1/2 WB	SED	Entire boars	Castrates	SED	1/4 WB genotype x gender	1/2WB genotype x gender	1/4 WB entire boars x 1/2 WB entire boars	1/4WB castrates x 1/2 WB castrates
Tenderness	6.76	6.13	0.19**	6.68	6.21	0.19*	*ns*	*	*ns*	*ns*
Juiciness	6.84	6.17	0.18	6.63	6.39	0.18	*ns*	*ns*	*ns*	**
Flavour	7.26	6.54	0.17***	6.50	7.30	0.17***	*ns*	*ns*	*ns*	*ns*
Odour	7.24	6.23	0.23***	6.07	7.39	0.23***	*ns*	***	***	*ns*
Pork odour in backfat	6.35	6.57	0.28	6,32	6.60	0.28	*ns*	*ns*	*ns*	*ns*
Abnormal odour of backfat	2.59	3.32	0.27**	3.18	2.73	0.27	*ns*	*ns*	*ns*	*ns*
Boar taint intensity	1.15	1.31	0.08*	1.49	1.00	0.08***	*	**	*ns*	*ns*

Significance levels: *$P<0.05$; **$P<0.01$; ***$P<0.001$; *ns* – not significant

SED-standard error of difference

Table 4. Correlation coefficients between sensory scores of *M. longissimus dorsi*, backfat and related parameters for entire boars

	Age	Weight of pigs	Testosterone	Weight of testes
Pork odour	-0.19*	0.11	-0.19*	-0.07
Tenderness	-0.21	-0.12	0.02	-0.11
Pork flavour	-0.18	-0.10	-0.13	-0.06
Juiciness	-0.21*	-0.05	0.14	-0.12
Fat odour	0.07	-0.07	0.19	0.001
Abnormal fat odour	0.16	-0.09	0.25*	0.02
Boar taint (androstenone)	0.19	0.09	-0.01	-0.00

Significance level:*$P<0.05$

CONCLUSION

At similar slaughter weight hybrids of the 1/4 WB genotype were younger and hybrids of this genotype from both genders had higher scores of sensory evaluation than hybrids of the 1/2 WB genotype. The meat from intact males influenced by wild boar introgression was found acceptable, therefore raising of intact hybrids is practicable and fulfils the conditions for animal welfare. It is a challenge to identify factors that might be influenced by boar taint in some of the carcasses. There is evidence to suggest that having optimised rearing conditions for hybrids with wild boar introgression could minimize boar taint.

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