Comparison of meat quality between barrows, boars and boars vaccinated against GnRH

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Abstract— **The aim of this study was to investigate potential differences in carcass and meat quality between barrows, boars and boars vaccinated against GnRH.**

Ninety-seven barrows (BA), 54 boars (BO) and 100 boars vaccinated against GnRH (Improvac®, IMP) were raised on the same farm. All pigs (hybrid sow x Pietrain boar) received the same diet. Individual lean meat percentage and warm carcass slaughter weight were determined at the slaughter line. On the day after slaughter, loin samples were collected the day after slaughter, vacuum packed and refrigerated until analysis of meat quality (meat colour, ultimate pH, drip loss, cooking loss and shear force). Boar taint of 25 BA, 46 IMP and 53 BO was assessed by evaluation with the hot iron method.

Carcass weight was comparable for all three groups. Meat percentage was lower (P<0.001) in BA (57.70%) than in IMP (60.23%) or BO (60.30%). Muscle thickness, measured on the *longissimus dorsi* (LD), was higher (P=0.021) for BA (62.4mm) and IMP (62.5mm) compared to BO (60.4mm). For IMP (14.2mm) and BO (13.6mm), fat thickness was lower (P<0.001) than for BA (17.7mm).

The ultimate pH in the loin was lower (P<0.001) in BO (5.4) than in BA or IMP (both 5.6). The CIELAB colour determinants did not differ between groups (P>0.1). Drip loss was lower (P<0.01) in BA (2.9%) than in both IMP (3.8%) and BO (3.8%). Cooking loss differed significantly (P<0.001), with the lowest loss for BA (28,3%), intermediate for BO (29.8%) and highest for IMP (30.8%). No differences in shear force were found between treatment groups (P>0.1).

Boar taint assessment with the hot iron method yielded more boar taint (P<0.001) in BO than in BA or IMP. Vaccination thus reduced the incidence of boar taint.

In the present study, carcass and meat quality of IMP was comparable to BO, but with a slightly higher ultimate pH.

Keywords— **Entire male pigs, immunocastration, meat quality**

I. INTRODUCTION

Vaccination of boars against GnRH (Improvac®) to avoid boar taint has been recently accepted for use in the European Union. While vaccination has been shown to be effective against boar taint, performances may differ between boars or boars vaccinated against GnRH. Boars and barrows have been shown to differ in carcass and meat quality [1]. Immunocastrates physiologically turn into barrows at a later age (4-8 weeks before slaughter depending on the time of second vaccination). The effect of this hormonal transformation on performance and carcass and meat quality remains unclear. Results vary greatly due to genetics [2], feeding (ad lib vs. restricted), time of second vaccination (4 weeks or more before slaughter) or housing (group or individually housed) as described by Skrlep et al. [3].

Therefore, a large scale on farm study was set up to compare carcass and meat quality characteristics of barrows, boars and boars vaccinated against GnRH in Belgium.

II. MATERIALS & METHODS

On a commercial farm, 108 male piglets (hybrid sow x Pietrain boar) were surgically castrated at 4 days of age (barrows, BA), 105 male piglets were kept entire (boars, BO) and 105 male piglets were vaccinated twice with a 2 mL dose given subcutaneously in the neck, the first time at 136 days of age and again at 163 days of age, or 4 weeks before slaughter (boars vaccinated against GnRH, IMP). At 10 weeks of age, the pigs were allocated to compartments according to treatment group. The pigs were housed in groups of 13 animals. All BA and IMP received the same diet. Fifty-four of the boars received the same diet as the BA and IMP, while the other 50 boars received an experimental diet to reduce boar taint (unpublished research). The latter group was excluded from the results of the present study. Pigs had free access to water at all times. Pigs were fasted for 24 hours before slaughter. All pigs were slaughtered on the same day by exsanguination after electric stunning. *Longissimus dorsi* muscle thickness, fat thickness, warm carcass weight and lean meat percentage were determined at the slaughter line with PG600. Lean meat content in the carcass was estimated based on this PG 600 measurement with the equation approved for use in Belgian abattoirs.

Daily feed intake, daily growth and feed conversion ratio were evaluated per compartment from 20 kg to slaughter.

Longissimus thoracis et lumborum samples with backfat layer were taken at the slaughterhouse 24 hours after slaughter, vacuum packed and stored under refrigeration until the meat quality analysis. The samples were trimmed of visible fat and cut into slices of 2.5 cm. pH48 was measured on two freshly cut meat samples per animal, at least 48 hours after slaughter. CIELAB colour determinants (L^*, a^*, b^*) were measured using a HunterLab miniscan (45/0 geometry), on two meat samples per animal after 15 minutes of blooming. Average values of pH_{48} and CIELAB colour determinants were used for further statistical analysis. Drip loss was determined on meat samples of about 150 g. Samples were hung by a nylon cord and placed in a plastic bag for 24h. The percentage drip loss is calculated as follows. After wiping the sample dry, the difference in weight of the meat sample before cooking and cooling and again afterward was divided by the sample weight x 100. To measure cooking loss and Warner-Bratzler shear force measurements, meat cuts (2.5 cm) were boiled in a closed plastic bag in a hot water bath of 75°C during 50 minutes, then cooled by placing the bagged samples in a cold tap water bath for 40 minutes. Shear force was determined for ten cores per meat sample and the average value was used for further analysis. Cooking loss (%) is defined as the difference in weight of the meat sample (after wiping dry) before the cooking and cooling and again afterward, divided by the sample weight x 100.

Boar taint was assessed using the hot iron method. Upon heating neck fat with a hot iron, an expert evaluates the odour on a scale from 0 to 4.

Results were analysed using variance analysis (STATISTICA 9, Statsoft, Tulsa, USA), with treatment as a fixed factor. Results were considered significant if $p<0.05$.

III. RESULTS AND DISCUSSION

Daily feed intake (DFI), daily gain (DG) and feed conversion ratio (FCR) were evaluated per compartment (Table 1), thus no statistics were performed on these data. DFI was highest for the BA and lowest for the BO. Daily gain was highest for IMP. This resulted in a better feed conversion ratio for IMP compared to BA. The numerical differences are in line with literature for *ad libitum* fed pigs [4].

Table 1 Performance of barrows (BA), boars (BO) and boars vaccinated against GnRH (IMP) measured at compartment level

	BA	BO	IMP
Daily feed intake (kg)	2,19	1,97	2,05
Daily gain (g)	782	774	812
Feed conversion ratio (kg/kg)	2,55	2,33	2,24

Warm carcass weight was not significantly affected by treatment. Lean meat percentage was higher for BO and IMP compared to BA (Table 2). The results for lean meat percentage agree with literature, with BO leaner than BA. In other studies, lean meat percentage of IM is often intermediate between BO and BA [4]. In the present study, however, lean meat percentage of IMP was comparable to that of boars, probably because only 4 weeks elapsed between the second vaccination and slaughter.

Muscle thickness, measured at *longissimus dorsi* (LD), was higher for BA and IMP compared to BO. Fat thickness of IMP and BO was lower than for BA. Fabrèga et al. [5] and Skrlep et al. [3] found similar results for fat thickness, but other studies reported more backfat thickness in IMP compared to BO [4]. Other studies revealed no differences for loin depth between BA, BO or IM [3,5].

BO had higher hot iron scores than BA or IMP, indicating that vaccination against GnRH was effective in reducing boar taint. This agrees with other studies [3,6,7]

All meat quality parameters were affected by treatment, except for shear force. pH48 was lower for BO than for BA or IMP. CIELAB colour determinants were affected as well. BA and BO tended to have lighter meat (L*) than IMP. The redness value (a*), was higher in IMP than in BA. The yellowness value (b*) was higher in IMP than in BO. Drip loss as well as cooking loss were lowest for BA compared to BO and IMP. Cooking loss was also higher for IMP compared to BO.

Table 2 Mean values of carcass and meat quality parameters of barrows (BA), boars (BO) and boars vaccinated against GnRH (IMP)

	BA	BO	IMP	s.e.[5]	P-value
Carcass (n)	*90*	*52*	*98*		
Weight (kg)[1]	93.6	90.1	92.9	0.59	***0.074***
Lean meat (%)	57.7^{x}	60.3^{y}	60.6^{y}	0.19	**<0.001**
LD Meat (mm)[2]	62.4^{y}	60.4^{x}	62.5^{y}	0.31	**0.021**
LD Fat (mm)[3]	17.7^{y}	13.6^{x}	14.2^{x}	0.21	**<0.001**
Meat quality (n)	*97*	*54*	*100*		
pH48[4]	5.6^{y}	5.4^{x}	5.6^{y}	0.01	**<0.001**
*L**	57.3	57.2	56.3	0.21	***0.066***
*a**	8.5^{x}	8.8^{xy}	8.9^{y}	0.07	**0.020**
*b**	16.4^{xy}	16.8^{y}	16.4^{x}	0.05	**0.020**
Drip loss (%)	2.9^{x}	3.8^{y}	3.8^{y}	0.10	**<0.001**
Cooking loss (%)	28.3^{x}	29.8^{y}	30.8^{z}	0.15	**<0.001**
Shear force (N)	28.0	28.1	28.4	0.30	0.778
Boar taint (n)	*25*	*53*	*46*		
Hot iron score	0.2^{x}	1.2^{y}	0.5^{x}	0.07	**<0.001**

[1]Warm carcass weight, [2]pH48: pH at least 48 hours after slaughter; [3]LD Meat: Longissimus dorsi meat depth, [4]LD fat: Longissimus dorsi fat thickness; *L**: Luminosity, *a**: redness, *b**: yellowness, [5]s.e.: standard error
[x,y,z]: Values within one row with no common superscript are significantly different at $p < 0.05$ according to Tukey's post hoc test.

In contrast to our findings, other studies revealed no significant differences between BA, BO and IMP for drip loss, cooking loss and pH [2,3,6,7,8].

Results for colour are inconsistent in literature. Pauly et al. [6] found no differences; Skrlep et al. [3] found only b* higher for BA compared to BO with IMP between the two; and Gispert [8] found the same result for a* as our results, but the opposite for L* as boars had darker meat than BA, with IMP between the two. Muscle fibre characteristics may depend on genotype which probably accounts for these differences. Whether or not the reported differences in meat quality are sufficient to affect consumer acceptance remains uncertain. Few studies have explored the effect of the various castration methods and their consequences for meat quality as evaluated by experts or consumers. Font i Furnols [10] investigated the experts' sensory evaluation of BA, BO, IMP and gilts (FE). The results indicated juicier pork from BA, FE and IMP compared to BO. BO pork was less tender than pork from BA or IMP. Consumers preferred the odour and flavour of BA, IMP and FE in comparison with BO [9]. D'Souza and Mullan [2] found no effect of castration method on pH, colour or drip loss, but the consumer evaluation (aroma, flavour, tenderness, juiciness, overall acceptability) revealed an interaction between genotype and castration method. Two genotypes were compared. For the lean genotype, BA were preferred over BO and IMP. For the other genotype, with propensity for increased subcutaneous fat deposition, consumers preferred IMP over BA and BO. In a previous experiment [11] BO had lower tenderness compared to BA, while shear force was unaffected.

It will be interesting to evaluate whether consumers experience differences in eating quality between BO, BA and IMP. More knowledge is also needed on the effect of these different castration methods and its interaction with genotype and time span between the second vaccination and slaughter on carcass and meat quality characteristics and consumers' sensory evaluation.

IV. CONCLUSIONS

In the present study, lean meat percentage, fat thickness and water holding capacity of boars vaccinated against GnRH was comparable to boars, but the vaccinated boars had a slightly higher ultimate pH. Vaccination against GnRH successfully reduced boar taint.

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