Effect of Immunocastration on Performance of Slovenian Pig Fatteners

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Summary

The influence of the immunocastration (immunisation against GnRH) on pig performance (growth, carcass and meat quality traits) was investigated in two parallel experiments (on two farms) with two crossbreeds – G1 (50% Duroc) and G2 (50% Pietrain). Within the crossbreed, the pigs were assigned to three experimental groups; entire males (EM, n=49), immunocastrates (IC, n=45) and surgical castrates (SC, n=45). Those assigned to IC group were vaccinated at the age of 12 and 19 weeks. Pigs were individually housed, their feed intake (*ad libitum*) and weight (at 12, 19 and 24 weeks) were recorded. At the age of 24 weeks, the pigs were slaughtered and their carcass and meat quality traits were assessed. We hypothesized that treatment response could have been different in two crossbreeds. However the interaction was insignificant, thus the treatment effect is presented on pooled results for both crossbreeds. Until the revaccination, IC were similar to EM pigs, thereafter they exhibited an increase in feed intake and growth rate. Overall, they presented an advantage in growth rate and feed efficiency as compared to SC. They also exhibited better carcass properties as SC without any major effect on meat quality. The present study provides the initial information on the immunocastration effect in Slovenian herds that should further be supported by testing it in usual rearing conditions and group housing.

Key words

pig, immunocastration, growth performance, carcass properties, meat quality

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Aim

Surgical castration of male piglets is practiced to prevent a development of unpleasant flavour (i.e. boar taint) occurring in meat of sexually mature boars (Bonneau et al., 2004) due to a deposition of skatole and androstenone in their fatty tissue (Patterson, 1968; Walstra and Maarse, 1970). Surgical castration without anaesthesia (presently a widely used practice) has been a subject of severe criticism from the animal welfare point of view (Giershing et al., 2006) and a ban on surgical castration without anaesthesia is foreseen in the EU countries within several years. In view of this, alternatives are being considered such as rearing of entire or immunocastrated males. Immunocastration is based on the vaccination against GnRH and has been proven efficient in boar taint elimination (Bonneau et al., 1994). The vaccine was registered in the EU in May 2009 and in many countries there's an interest to study this alternative in local conditions. In accordance with the current trends, it was our objective to evaluate growth performance, carcass and meat quality of immunocastrates, entire males and surgical castrates in two commercial crossbreeds.

Material and methods

Experimental design. Pigs of two crossbreeds G1 (50% Duroc) and G2 (50% Pietrain), raised in parallel experiments on two pig farms were used for the present study. Pigs had the same vaccination timing and very similar rearing conditions. They were lodged individually and fed *ad libitum* commercially available feed mixtures. Experimental pigs originated from 35 litters of G1 and 36 litters of G2 farrowed within two weeks period. Pigs (1-2 surgical castrates, and 3-4 boars from the same litter) were individually marked. At the age of 12 weeks, the pigs were transferred to the experimental stables (individual pens) and assigned to three groups: entire males (EM), immunocastrates (IC) and surgical castrates (SC). Young boars assigned to IC group were vaccinated twice against GnRH (at the age of 12 and 19 week) by subcutaneous injection of 2 ml of Improvac® vaccine (Pfizer Animal Health). Feed intake was recorded individually and pigs were weighed at 12, 19 and 24 weeks of age, when they were slaughtered. From the gathered data, daily gain and feed conversion ratio were calculated.

Carcass and meat quality measurements. Pigs were slaughtered in commercial abattoirs according to standard slaughter procedure (app. 1 hour of transport, 2 hours of lairage, CO_2 stunning, vertical exsanguination, vapour scalding, dehairing and evisceration, followed by the veterinary inspection and carcass classification according to SEUROP, using a method approved for Slovenia (OJ EU L56/28, 2008). Measurement of pH in *longissimus dorsi* muscle (LD) was taken 45 minutes (pH_{45}LD) and 24 hours (pH_{24}LD) after slaughter using a MP120 Mettler Toledo pH meter (Mettler-Toledo GmbH, Schwarzenbach, Switzerland) fitted with a combined glass electrode (InLab427) previously calibrated at pH 4.0 and 7.0. A day following the slaughter, additional carcass and meat quality traits were evaluated. The hind leg was cut off between 6^{th} and the 7^{th} lumbar vertebra and the shank was removed. The weight of the leg (ham) was recorded before and after the removal of the skin and subcutaneous fat. A cross section of the carcass was made at the level of last rib and the image of LD was taken using a digital photo camera (Canon PowerShot G3, Canon Inc., Tokyo, Japan). Loin eye area (surface of LD) was determined on the images with the aid of LUCIA. NET 1.16.5. software (Laboratory Imaging s.r.o., Prague, Czech Republic). The measurements of the colour and pH were taken on the freshly cut surface of LD. Colour was assessed using 1-6 point Japanese colour scale (Nakai et al., 1975) and CIE Lab measurements using Minolta Chroma Meter CR-300 (Minolta Co. Ltd., Osaka, Japan) with an 11 mm aperture, D_{65} illuminant, calibrated against a white tile. Caudally from the level of last rib, two 2.5 cm thick slices of LD were taken, one for determination of drip loss (after 24 and 48 hours) according to EZ method (Christensen, 2003) and for the determination of intramuscular fat with NIRS (NIR System model 6500 Spectrometer, Silver Spring, MD, USA) according to Prevolnik et al. (2005).

Statistical analysis. For the comparison of the treatment groups (i.e. IC, SC or EM) one-way anova (procedure GLM, SAS Inc., Cary, NC, USA) was used. The statistical model included the effects of treatment group, crossbreed and their interaction (insignificant). When a significant group effect ($P<0.05$) was detected, means were compared using a Tukey test. Carcass weight (as a covariate) or slaughter batch were included in the model for carcass or meat quality, respectively.

Results and discussion

A possible difference in treatment response in two crossbreeds was hypothesized. However, the statistical analysis revealed no significant interaction between treatment group and crossbreed (experiment) that was the reason for us to present pooled results for the treatment effect (Table 1). The differences between the crossbreeds used in the parallel experiments were significant for the majority of the measured traits. In the experiment 1 with Duroc crosses (G1) higher daily gain, better feed intake and lower feed efficiency was observed compared to experiment 2 in which Pietrain crosses were used. At the same age, G1 pigs were heavier, had thicker backfat and lower meat %. Crossbreed differences *per se* were, however, of no interest in the present study, therefore they are not further discussed. In the case of meat quality traits crossbreed effect is confounded with the abattoir effect, therefore the results have no practical value and are not shown.

Growth performance. No differences between experimental groups were noted for daily gain in the period between the first and second vaccination (12 and 19 weeks), but after the second vaccination IC pigs had higher daily gain than SC (18%; $P<0.05$) or EM pigs (14%, NS). As a consequence overall daily gain for the whole fattening period (12-24 weeks) was higher in IC as compared to EM and SC pigs (5.5% and 5.3%, respectively; $P<0.05$). Prior to the second vaccination (in this period IC are physiologically still males) feed intake was higher in SC as compared to EM or IC, whereas after the immunisation (19-24 weeks), the highest increase of consumption was observed for IC pigs (significantly different from EM pigs). In spite of the increased feed intake in the second experimental phase, the feed conversion efficiency of IC was not significantly higher compared to EM pigs, while EM and IC showed significantly better feed efficiency as SC pigs. It is a well established fact that boars exhibit better growth perfor-

Table 1. Growth, carcass and meat quality traits* (LSMEAN) in immunocastrates (IM), surgical castrates (SC) and entire males (EM) of two different crossbreeds/experiments (G1, G2).

	IM	SC	EM	P_T	G1	G2	P_C	rmse	P_{TxC}
Number of pigs	45	44	49		73	65			
Daily gain, g/day									
12[1]-19[2] weeks	980	986	961	0.4168	1026	924	<0.0001	96	0.0996
19-24[3] weeks	1114^{b}	943^{a}	977^{ab}	0.0172	1051	972	0.1209	296	0.8737
12-24 weeks	1020^{b}	967^{a}	969^{a}	0.0138	1025	944	<0.0001	97	0.0907
Daily feed intake, kg/day									
12-19 weeks	2.32^{a}	2.54^{b}	2.28^{a}	<0.0001	2.65	2.11	<0.0001	0.24	0.3388
19-24 weeks	3.80^{b}	3.52^{ab}	3.16^{a}	0.0167	3.79	3.20	0.0017	1.08	0.5958
12-24 weeks	2.88^{b}	2.97^{b}	2.67^{a}	<0.0001	3.09	2.60	<0.0001	0.27	0.9164
Feed efficiency, kg feed/kg gain									
12-19 weeks	2.37^{a}	2.58^{b}	2.37^{a}	<0.0001	2.59	2.28	<0.0001	2.45	0.2633
19-24 weeks	3.43^{a}	3.79^{b}	3.28^{a}	<0.0001	3.63	3.37	0.0009	0.44	0.0655
12-24 weeks	2.82^{a}	3.08^{b}	2.77^{a}	<0.0001	3.01	2.77	<0.0001	0.22	0.0810
Carcass traits									
Carcass weight, kg	88.0	88.6	87.6	0.8700	93.1	83.0	<0.0001	8.5	0.0793
Muscle[4], mm	71.0	70.2	70.7	0.7085	72.1	69.1	0.0018	4.6	0.5215
Fat[5], mm	13.6^{b}	16.7^{c}	11.6^{a}	<0.0001	15.3	12.6	0.0002	3.6	0.9212
Lean meat, %	59.5^{b}	57.2^{a}	61.0^{c}	<0.0001	58.4	60.0	0.0033	2.7	0.8613
Leaf fat, kg	1.1^{b}	1.2^{b}	0.7^{a}	<0.0001	1.1	0.9	0.0016	0.3	0.0950
LEA[6], cm^2	47.5	47.0	46.8	0.6840	46.6	47.6	0.2115	4.0	0.9002
Ham, kg	11.0^{b}	10.9^{ab}	10.6^{a}	0.0079	10.8	10.9	0.5490	0.6	0.0815
Ham meat+bones, %	82.7^{b}	80.5^{a}	85.2^{c}	<0.0001	81.9	83.7	0.0029	0.6	0.5168
Meat quality traits*							Not shown*		
Intramuscular fat,%	1.6^{a}	2.1^{b}	1.6^{a}	<0.0001					0.6204
$pH_{45}LD$[7]	6.32	6.26	6.35	0.1046					0.7864
$pH_{24}LD$[8]	5.56^{ab}	5.55^{a}	5.63^{b}	0.0267					0.8632
Color (1-6)	3.7	3.7	3.9	0.0667					0.2148
Minolta L	49.1	48.8	47.7	0.0617					0.3815
Minolta a	6.9	7.0	6.9	0.6571					0.5504
Minolta b	2.3	2.5	2.4	0.3599					0.0963
Drip loss 24h, %	3.0	2.4	2.9	0.2133					0.0764
Drip loss 48h, %	5.1	4.2	4.9	0.1984					0.0916

*crossbreed effect is confounded with the abattoir effect, therefore the results are not shown [a,b]=P<0.05; P_T – P value for treatment; P_C – P value for crossbreed/experiment; P_{TxC} – P value of interaction between crossbreed/experiment and treatment; [1]12 weeks – first vaccination of immunocastrates, [2]19 weeks – second vaccination of immunocastrates, [3]24 weeks – slaughter; [4]Muscle - the shortest distance between cranial end of *gluteus medius* muscle and dorsal edge of vertebral canal; [5]Fat - minimal fat thickness over *gluteus medius* muscle [6]Loin eye area; [7,8]pH in LD muscle after 45min and 24h.

mance than surgical castrates, which was confirmed in the present study. There is, however, no such coherence in the literature reports about the immunocastrates. Whereas in some studies no effect of the immunocastration was reported on growth performance (Falvo et al., 1986), other studies mention trends for better average daily gain (Jaros et al., 2005; Schmoll et al, 2009) and feed efficiency (Miclat-Sonaco et al., 2008) of immunocastrates than surgical castrates. Similarly as in our study, several reports (Dunshea et al., 2001; Cronin et al., 2003; Oliver et al., 2003) showed immunocastrates to grow faster as entire males in the period after the revaccination. This finding could be explained with the fact that entire males consume less feed and waste more energy due to their aggressive behaviour, while the immunocastrates still retain boar-like levels of growth hormone (Metz et al., 2002). It is also worth mentioning, that the most possible reason for the inconsistent literature reports is a high variation in experimental designs including differences in the vaccination protocol, selection of breeds/genotype and rearing environment.

Carcass traits. A significant effect of the treatment group was observed for several carcass properties associated to fatness, whereas almost no difference was observed in the case of muscularity (*gluteus medius* muscle thickness, loin eye area) and carcass weight. As expected, EM exhibited lower fatness (fat thickness over *gluteus medius* muscle, leaf fat) and higher lean meat % (carcass and ham) compared to SC. The IC pigs took intermediate position differing (P<0.05) either from EM or SC, except in the case of leaf fat where similarity with SC was noted. Additionally, IC provided heavier hams as EM pigs. Comparison of our results to the literature reports shows, again, the inconsistency of the results. Whereas one of the early studies (Falvo et al., 1986) showed immunocastrates to be even fatter as surgical castrates, other studies report either no differences (Metz et al., 2002) or position the immunocastrates closer to boars (Pauly et al., 2009; Gispert et al., 2010). Studies, where immunocastrates were compared only to surgical castrates (Schmoll et al., 2009; Fuchs et al., 2009), however showed the benefits of the former in terms of lower backfat and higher leanness. In conclusion, generally immunocastrates are reported to be leaner as surgical castrates and fatter than boars. Here again, it can be emphasised, that the age and especially the timing of vaccination may be affecting the results.

Meat quality. The comparison of treatment groups in regard to meat quality traits revealed significant effect in the case of intramuscular fat (IMF) and ultimate pH of LD muscle. IM and EM showed lower IMF values than SC, which is not consistent with other results for fatness, where IC revealed intermediate position (fat over *gluteus medius* muscle) or position closer to SC (leaf fat). EM exhibited higher pH_{24} values than SC, while no difference to EM or SC was observed for IC pigs. The differences in pH are also reflected on colour, showing the same trend ($P<0.07$), i.e. darker colour in the case of EM. The result is coherent with the literature data, suggesting that boars, due to higher level of physical activity, deplete more muscle glycogen prior to slaughter resulting in higher meat pH (Fernandez et al., 1994; Sather et al., 1995; D'Souza et al., 1998). Literature reports on the topic of immunocastration and meat quality is not abundant and the majority of existing reports failed to find differences in meat quality due to the immunocastration (Gispert et al., 2010, Pauly et al., 2009; Silveira et al., 2008).

Conclusions

Until the revaccination, the immunocastrates were similar to boars, thereafter they exhibited an increase in feed intake and growth rate. Overall, they present an advantage in growth rate and feed efficiency as compared to surgical castrates. Moreover, they have better carcass properties without any major effect on meat quality. Treatment effect was not different in the case of two parallel experiments with two crossbreeds.

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