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Effect of time of second GnRH vaccination on feed intake, carcass quality and fatty acid composition of male fatteners compared to entire boars and barrows

Einfluss des Zeitpunktes der zweiten GnRH-Vakzination auf Futteraufnahme, Schlachtkörperqualität und Fettsäuremuster männlicher Mastschweine im Vergleich zu intakten Ebern und Kastraten

Tatjana Sattler[1], Franziska Sauer[1], Friedrich Schmoll[2]

Summary

Objective of the study was to evaluate the influence of time point of second vaccination with the GnRH analogon Improvac® on growth performance, carcass quality and fatty acid composition of male fatteners compared to surgically castrated pigs and entire boars. The pigs (Piétrain-crossbreds) were divided into two vaccination groups with first GnRH vaccination at eleven weeks of age and second vaccination at 21 (group IA, n = 84) or 18 weeks (IB, n = 83) of age, one group with surgically castrated males (C, n = 90) and one with entire males (EM, n = 91). Body weight, feed conversion rate, carcass quality and fatty acid composition in back fat were estimated. Feed conversion rate until second vaccination was better ($P < 0.05$) in the vaccination groups (1:2.39) and in group EM (1:2.34) than in group C (1:2.55). Carcass weight did not differ between the groups. Vaccination groups had significantly ($P < 0.01$) leaner meat (IA: 58.9%, IB: 58.3%) and less back fat (IA: 14.6 mm, IB: 15.5 mm) than group C (56.5%, 17.1 mm). Fatty acid composition was shifted to polyunsaturated fatty acids (PUFA) in back fat in vaccination groups and EM compared to C. The time lag between second vaccination and slaughter had no influence on growth performance, feed intake and carcass quality. C18:3 and C20:2 were significantly ($P < 0.01$) higher in group IB than in IA, but PUFA did not differ between vaccination groups. GnRH vaccinated fatteners were economically superior to surgically castrated in this study.

Keywords: Improvac®, pig, GnRH, growth performance, feed conversion rate, fatty acids

Zusammenfassung

Ziel der Studie war, den Einfluss des Zeitpunktes der zweiten Impfung mit dem GnRH-Analogon Improvac® auf Mastleistung, Schlachtkörperqualität und Fettsäuremuster männlicher Mastschweine im Vergleich zu intakten Ebern und Kastraten zu ermitteln. Die Studientiere (Piétrain-Masthybriden) wurden in zwei Impfgruppen mit der ersten GnRH-Vakzination in der elften Lebenswoche und der zweiten Impfung in der 21. (IA, n = 84) bzw. 18. (IB, n = 83) Lebenswoche, eine Gruppe mit chirurgisch kastrierten (C, n = 90) und eine mit intakten männlichen Mastschweinen (EM, n = 91) eingeteilt. Körpermasse, Futterverwertung, Schlachtkörperqualität und Fettsäuremuster im Rückenfett wurden gemessen. Die Futterverwertung bis zur zweiten Vakzination war in den Impfgruppen (1:2,39) und in Gruppe EM (1:2,34) besser ($p < 0,05$) als in Gruppe C (1:2,55). Das Schlachtgewicht unterschied sich zwischen den Gruppen nicht. Die Impfgruppen hatten einen signifikant ($p < 0,01$) höheren Magerfleischanteil (IA: 58,9 %, IB: 58,3 %) und weniger Rückenfett (IA: 14,6 mm, IB: 15,5 mm) als Gruppe C (56,5 %, 17,1 mm). Das Fettsäuremuster war in den Impfgruppen und in Gruppe EM, verglichen mit Gruppe C, in Richtung mehrfach ungesättigte Fettsäuren (PUFA) verschoben. Der Abstand der zweiten Impfung zur Schlachtung hatte keinen Einfluss auf Mast-

leistung, Futteraufnahme und Schlachtkörperqualität. Einige PUFA (C18:3, C20:2) waren in Gruppe IB signifikant ($p < 0,01$) höher als in IA, wohingegen sich die Summe der PUFA zwischen den Impfgruppen nicht unterschied. GnRH-geimpfte Mastschweine waren den chirurgisch kastrierten Schweinen hinsichtlich ökonomischer Aspekte in dieser Studie überlegen.

Schlüsselwörter: Improvac®, Schwein, GnRH, Mastleistung, Futterverwertung, Fettsäuren

Introduction

The vaccination of male fatteners with the gonadotropin releasing hormone (GnRH) analogon Improvac® prevents not only the occurrence of boar taint but has an influence on carcass and meat quality as well (Dunshea et al., 2001; Font-i-Furnols et al., 2012; Mackay et al., 2013). The vaccination is administered twice with at least four weeks between first and second application. According to Dunshea et al. (2001) the first dose has no effect on testes function or testosterone concentration in serum. The second vaccination is recommended four to six weeks prior to slaughter. After second vaccination, antibodies against GnRH are developed (Dunshea et al., 2001) and LH and FSH secretion is suppressed (Falvo et al., 1986). Testosterone concentration in serum becomes similar to that of surgically castrated boars (Dunshea et al., 2001).

Several studies discussed the faster growth, increase of lean meat in comparison to surgically castrated fatteners as well as a decrease in back fat thickness (Schmoll et al, 2009; Morales et al., 2010; Boler et al., 2012). Furthermore, studies also detected a better feed conversion rate in comparison with surgically castrated fatteners (Fuchs et al., 2011). The cause of this development is the fact that vaccinated boars perform and behave like entire boars until second vaccination (Dunshea et al., 2001; Baumgartner et al., 2010).

After second vaccination, feed intake increases (Dunshea et al., 2001, 2013). The increased feed intake can cause higher feed costs but may also lead to faster growth as was found in several studies (Zamaratskaia et al., 2008; Fuchs et al., 2011). The fatteners are less active after second vaccination (Baumgartner et al., 2010; Fàbrega et al., 2010) and back fat thickness shows a tendency to be higher, whereas the lean meat tends to be lower in comparison to entire boars (Dunshea et al., 2001; Zamaratskaia et al., 2008; Pauly et al., 2009). The risk of increased subcutaneous fat deposition in carcasses, and thereby the decrease of sales proceeds from fatteners receiving second GnRH vaccination at an earlier time point, is suspected (Andersson et al., 2012), although some studies estimated no differences of carcass quality between different time lags from second vaccination to slaughter (Boler et al., 2012).

According to Wood et al. (2008), with increased back fat thickness the fatty acid composition in back fat changes. The authors explain this statement with the fact that for newly synthesized fat tissue, saturated and monounsaturated fatty acids in the diet play a more important role than polyunsaturated fatty acids, especially 18:2n-6. Fat quality and meat processing quality is influenced by the fatty acid composition of subcutaneous fat (Wood et al., 2008). On one hand, some polyunsaturated fatty acids (PUFA), especially n-3 PUFA, have beneficial dietary effects in humans (Li et al., 2008; Whelan, 2008). On the other hand, adipose tissue of pigs contains a higher level of n-6 PUFA than n-3 (Wood et al., 2008). Furthermore, a high percentage of PUFA in fat can cause problems with slicing yield and oiliness. For high quality meat products, a certain amount of saturated fatty acids (SFA) is necessary (Lyndgaard et al., 2012). Fatty acid composition of GnRH vaccinated fatteners seems to be similar to that of entire males (Mackay et al., 2013). Several authors, however, detected no differences in meat quality between surgically castrated and GnRH vaccinated male fatteners (Gispert et al., 2010; Font-i-Furnols et al., 2012; Sattler and Schmoll, 2013).

The aim of the study was to determine if there is an influence of different time lags between second vaccination with the GnRH analogon Improvac® and slaughter on growth performance, feed intake, carcass quality and fatty acid composition in back fat under commercial production conditions. The results had to be evaluated in comparison to surgically castrated as well as entire male fatteners. A further aim was to consider economic impacts like feed costs and carcass proceeds.

Material and Methods

Animals, treatment and vaccination

The study included 420 pigs of a German piglet production farm and was carried out under commercial production conditions. All pigs were crossbreds of Danish Yorkshire x Danish Landrace (sow) and Piétrain (boar). On the third day of life, the piglets were randomely allocated into four groups, each containing 105 piglets. Two GnRH vaccination groups were arranged and first vaccination with a GnRH analogon (Improvac®, Zoetis Deutschland GmbH, Berlin, DE) given at the eleventh week of age and the second vaccination at 21 weeks of age (group IA) or 18 weeks of age (IB), respectively. The third group contained entire boars (EM) and the fourth group consisted of surgically castrated male piglets (C). Surgical castration was done on the third day of life after injection of the non-steroidal anti-inflammatory drug Meloxicam (0.4 mg/kg i. m., Metacam®, Boehringer Ingelheim Vetmedica GmbH, Ingelheim, DE).

Housing and feeding

After a suckling period of four weeks, the piglets were allocated into a nursery, with 55 piglets per barn, treatment groups separated. The smallest piglets of each group were routinely sold separately and therefore excluded from the study.

At eleven weeks of age, the pigs (IA n = 84, IB n = 83, EM n = 91, C n = 90) were allocated into the fattening

unit with about 30 pigs per barn and treatment groups in separate barns. They were fed ad libitum. In most cases, two barns were fed from the same feeder valve. Four barns had their own feeder valve. Therefore, for each treatment group the feed intake per week was measured for about 60 and 30 pigs, respectively. The exact amount of pigs per barn was available for each fattening day and was used for the calculation of feed intake. Feed consumption rate per pig was calculated for each treatment group over the duration of the fattening period. Feed composition of growing and finishing diet is shown in Table 1. Body weight per barn was measured at the day of allocation to the fattening unit as well as at 18 weeks of age (time point of second GnRH vaccination in group IB). The feed conversion rate at the fattening unit was calculated per treatment group up until this time point. The total feed costs over the fattening period per pig were estimated.

TABLE 1: *Feed composition for the study pigs in grower and finisher unit (ingredients in weight %)*

	Growing diet	Finishing diet	
	<34 fattening days / 42 kg body weight	Early period <83 kg body weight	Late period >83 kg body weight
Potatoes	6%	17%	20%
Maize	35%	42%	38%
Soya bean	18.5%	21%	14%
Barley	26%	17%	24.6–25%
Mineral feed	13.5%	3%	2.5%
Dry matter	20%	20%	20%

TABLE 2: *Feed intake, body weight, feed consumption rate and feed costs per pig of male fatteners receiving second GnRH vaccination at different time points prior to slaughter, entire boars and surgically castrated pigs in fattening unit (mean ± standard deviation)*

	Group			
	IA	IB	EM	C
Body weight 11 weeks old (kg)	28.2 ± 1.1	27.4 ± 1.1	27.8 ± 0.9	28.2 ± 1.1
Body weight 18 weeks old (kg)	71.4 ± 1.7	70.0 ± 1.3	70.7 ± 3.4	72.2 ± 1.4
Daily weight gain 11–18 weeks old (g)	881.2 ± 11.3	869.4 ± 26.5	875.5 ± 28.4	897.9 ± 7.1
Feed intake 11–18 weeks old (kg)	103.3[a] ± 6.2	101.9[a] ± 7.0	100.4[a] ± 7.4	112.0[b] ± 5.4
Feed conversion rate 11–18 weeks old	1:2.39[a]	1:2.39[a]	1:2.34[a]	1:2.55[b]
Feed consumption over fattening period (kg)	322.9[a] ± 8.1	317.6[a] ± 5.4	307.9[b] ± 10.6	332.9[c] ± 10.0
Total feed costs in fattening period (€)	77.98 ± 2.11	76.70[a] ± 1.80	74.36[a] ± 1.65	80.26[b] ± 2.94

a-b; a-c; b-c significant difference $P < 0.05$
IA: male fatteners, second GnRH vaccination at 21 weeks of age (n = 82)
IB: male fatteners, second GnRH vaccination at 18 weeks of age (n= 79)
EM: entire males, no study-related treatment (n = 88)
C: male fatteners, surgical castration at third day of life (n = 88)

TABLE 3: *Carcass quality and sales proceeds of male fatteners receiving second GnRH vaccination at different time points prior to slaughter, entire boars and surgically castrated pigs at slaughter (mean)*

	Group				
	IA	IB	EM	C	s.e.
Carcass weight (kg)	101.2	99.9	100.9	99.4	0,488
Lean meat (%)	58.9[a]	58.3[a]	59.8[c]	56.5[b]	0,166
Back fat thickness (mm)	14.6[a]	15.5[a]	13.5[c]	17.1[b]	0,179
Sales proceeds per kg (€)	1.90[a]	1.90[a]	1.91[a]	1.87[b]	0,004
Sales proceeds per carcass (€)	191.85[a]	189.65	192.54[a]	185.88[b]	0,957

a-c significant difference $P < 0.05$
a-b; b-c significant difference $P < 0.001$
s.e.: standard error of mean
IA: male fatteners, second GnRH vaccination at 21 weeks of age (n = 82)
IB: male fatteners, second GnRH vaccination at 18 weeks of age (n = 79)
EM: entire males, no study-related treatment (n = 88)
C: male fatteners, surgical castration at third day of life (n = 88)

Slaughter and carcass quality

At the end of fattening period, data of 337 study pigs were available for analysis. When they were 26 weeks old, 55 pigs out of each group were slaughtered at an abattoir about 50 km from the fattening unit. The remaining pigs (IA n = 27, IB n = 24, EM n = 33, C n = 33) were slaughtered with 27 weeks of age at the same abattoir. Carcass weight, lean meat and back fat thickness of each carcass as well as sales proceeds per carcass and per kg carcass weight were calculated similar to the description by Schmoll et al. (2009).

Analysis of fatty acid composition in back fat, boar taint compounds

Fatty acid composition in back fat was measured in 40 randomly selected pigs of each group. Back fat samples for analysis were taken at 30 min after exsanguination, immediately before the carcasses were placed into the cold store, from subcutaneous adipose tissue (both layers) between tenth and twelfth rib. The samples were transferred from slaughter house to the lab in cool bags and kept frozen at –20°C until analysis. Fatty acid composition was determined by gas chromatography (ELFI Analytik GbR, Neufahrn, DE) as performed by Pauly et al. (2009) and described by Bee (2001). SFA, monounsaturated fatty acids (MUFA) and PUFA were summarised for each group, respectively. Desaturation index was calculated as described by Bee (2001).

To detect boar taint compounds, androstenone and skatole concentrations in back fat were measured in the same amount of samples by gas chromatography as described by Fischer et al. (2011). Samples with androstenone concentrations of more than 1000 ng/g and skatole concentrations of more than 200 ng/g were classified as malodourous in terms of boar taint (Lealiifano et al., 2011).

Statistical analysis

The data were tested for normal distribution by Kolmogorow-Smirnov test. In normally distributed parameters, differences between groups were tested with Anova and Bonferroni as post-hoc test. In not normally distributed parameters, differences between groups were tested with Kruskall-Wallis test followed by Mann-Whitney test. Differences with an error of possibility $P < 0.05$ were considered significant. Correlations were tested with a rank correlation coefficient

after Spearman because most tested parameters were not normally distributed. Correlation coefficient r was indicated in the text if a correlation was discovered.

Results

Body weight, feed intake and feed conversion rate

Upon arrival at the fattening unit, the vaccination groups and group EM tended to have a lower body weight than group C ($P > 0.05$). Development of body weight in fattening period, feed conversion rate until second GnRH vaccination of group IB (18 weeks of age) and feed consumption over the whole fattening period as well as the calculated feed costs are shown in Table 2. Body weight at second Improvac® vaccination did not differ between the groups. Feed conversion rate until second vaccination did not differ between group IA and IB and was significantly ($P < 0.05$) better in those groups and in group EM than in group C. Total feed intake over the fattening period and total feed costs tend to be higher in IA than in IB ($P > 0.05$). Feed intake per day over fattening period, measured on a weekly basis, is shown in Figure 1. A slight decrease of feed intake in fattening week seven is seen in all groups, but mostly in group C. This was the time point of body weight measurement. Both vaccination groups have a significantly ($P < 0.05$) lower feed intake, a better feed conversion rate and lower feed costs than group C.

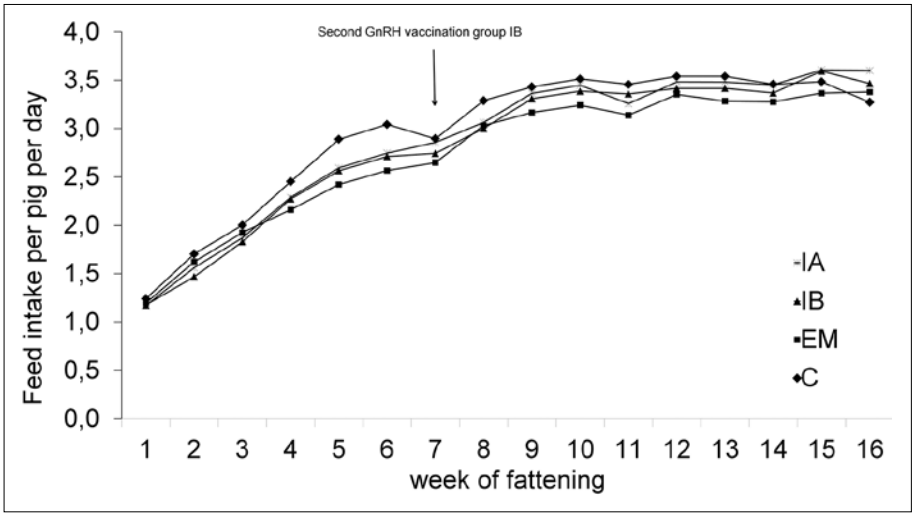

FIGURE 1: *Feed intake per day, measured on a weekly basis, of male fatteners receiving second GnRH vaccination at different ages, entire boars and surgically castrated pigs over fattening period (mean, kg).*

Carcass quality, androstenone and skatole in back fat

Because the slaughter of all of the pigs was on a fixed date, the fattening time was equal in all groups. Nevertheless, carcass weight did not differ significantly between the treatment groups. Table 3 gives an overview of carcass weight, lean meat, back fat thickness, sales proceeds per carcass and per kg carcass weight for each treatment group. No differences were detected between the two slaughter dates (26 and 27 weeks old). Lean meat was at a high level in all treatment groups. Group IA, IB and EM however, had a significantly higher lean meat percentage ($P < 0.001$) and lower back fat thickness ($P < 0.001$) than group C. Group EM had a significantly higher lean meat percentage and lower back fat thickness than the vaccination groups ($P < 0.05$) as well. No difference could be estimated between the vaccination groups. The same applied for the sales proceeds per kg carcass. Both vaccination groups and group EM reached a significantly higher price per kg than group C ($P < 0.001$), although two pigs of group IA and one pig of EM were paid for with a lower price per kg because they had reached a carcass weight of more than 120 kg. Sales proceeds per carcass were significantly higher in groups IA and EM than in group C ($P < 0.001$). Out of the 40 back fat samples of the pigs of group EM, ten samples (25%) had an androstenone concentration of more than 1000 ng/g, and two (5%) a skatole concentration of more than 200 ng/g. Potential losses because of malodour in terms of boar taint were not included in the sales proceeds calculation. No increased levels of androstenone and/or skatole were found in groups IA, IB and C.

Fatty acid composition in back fat

Table 4 shows the fatty acid composition and the sum parameters SFA, MUFA and PUFA and the desaturation index in the groups. The major SFA C16 and C18 as well as C20 are significantly ($P < 0.01$) lower in group EM than in the other groups. As a consequence, SFA as sum parameter present a significantly lower percentage in group EM ($P < 0.01$) than in the other groups. MUFA did not differ between the vaccination groups and group EM but were significantly lower in groups IA and EM than in group C ($P < 0.01$). This is particularly seen in C18:1 and C20:1. There was a positive correlation to back fat thickness both in SFA ($r = 0.54$) and MUFA ($r = 0.57$) over all pigs. Long chained PUFA present a significantly higher percentage in group EM ($P < 0.01$) and a significantly lower percentage in group C ($P < 0.01$) than in the vaccination groups. These significances are seen in all PUFA (C18:2, C18:3, C20:2 and C20:3+4, $P < 0.01$). A negative correlation ($r = 0.71$) between PUFA and back fat thickness over all pigs was found. Desaturation index was higher in group EM than in the vaccination groups and group C.

Discussion

Several studies refer about the effect of early GnRH vaccination on reproduction organs and boar taint (Einarsson et al., 2011; Andersson et al., 2012), adaptation of time of second vaccination closer to slaughter (Lealiifano et al., 2011) or adjustment of time of slaughter and therewith the time lag between second vaccination and slaughter (Boler et al., 2012). Until now, however, no study is available that refers to growth performance, carcass quality and fatty acid composition in back fat of male fatteners that received second vaccination with Improvac® at different time points prior slaughter and were slaughtered at the same age.

Although the vaccination groups and group EM tend to have a lower body weight (P > 0.05) at arrival at the fattening unit than group C, growth performance did not differ between the groups until week 18 of age, when the first group (IB) received second vaccination. Other studies refer to no differences in body weight at the beginning of the fattening period (Pauly et al., 2009; Fàbrega et al., 2010; Fuchs et al., 2011). Dunshea et al. (2001) found a lower body weight in GnRH vaccinated than in surgically castrated pigs at 15 weeks of age.

The better feed conversion rate of the vaccination groups and group EM compared to group C is in agreement with several other studies confirming the fact that GnRH vaccinated fatteners present like entire boars until second vaccination (Fàbrega et al., 2010; Millet et al., 2011; Albrecht et al., 2012).

Feed intake in both vaccination groups over the whole fattening period was higher than in group EM but lower than in group C. We could not confirm the effect of increased feed intake after second GnRH vaccination found in other studies (Pauly et al., 2009; Millet et al., 2011; Weiler et al., 2013). On the contrary, feed intake over fattening period tended to be higher in group IA (P > 0.05), vaccinated closer to slaughter, than in IB.

TABLE 4: *Fatty acid composition in back fat of male fatteners receiving second GnRH vaccination at different time points prior to slaughter, entire boars and surgically castrated pigs (mean, weight %)*

	Group				
	IA	IB	EM	C	s.e.
C8	0.01	0.01	0.01	0.01	0,000
C10	0.08	0.08	0.08	0.08	0,001
C12	0.09	0.09	0.09	0.09	0,001
C14	1.44	1.43	1.39	1.44	0,008
C14:1	0.02	0.02	0.02	0.02	0,001
C15	0.06	0.07	0.07	0.06	0,001
C16	25.59^{a}	25.62^{a}	24.38^{b}	26.02^{a}	0,090
C16:1	2.07	2.11	2.09	2.11	0,019
C17	0.39	0.42	0.42	0.36	0,009
C18	14.85^{a}	14.83^{a}	13.65^{b}	15.06^{a}	0,090
C18:1	38.68^{a}	39.44	39.05^{a}	40.05^{b}	0,115
C18:2	12.85^{a}	12.11^{a}	14.64^{b}	11.03^{c}	0,150
C18:3	0.79^{a,c}	0.76^{a}	0.94^{b}	0.70^{a,d}	0,011
C20	0.18^{a}	0.18^{a}	0.16^{b}	0.20^{c}	0,002
C20:1	0.79	0.81^{a}	0.74^{b}	0.85^{a}	0,008
C20:2	0.55^{a}	0.52^{b}	0.60^{c}	0.49^{b}	0,006
C20:3+4	0.45^{a}	0.43^{a}	0.52^{b}	0.39^{c}	0,006
C24	0.08^{a}	0.08^{a}	0.09^{b}	0.07^{c}	0,001
SFA	42.78^{a}	42.81^{a}	40.34^{b}	43.38^{a}	0,167
MUFA	41.56^{a}	42.37	41.89^{a}	43.02^{b}	0,122
PUFA	14.64^{a}	13.81^{a}	16.70^{b}	12.61^{c}	0,170
Desaturation index					
C16:1/C16	0,08^{a}	0,08	0,09^{b}	0,08^{a}	0,001
C18:1/C18	2,62^{A}	2,68^{A}	2,88^{B}	2,67^{A}	0,022

a-b, a-c, b-c, c-d significant difference P < 0.01
A-B significant difference P < 0,001
s.e.: standard error of mean
IA: male fatteners, second GnRH vaccination at 21 weeks of age (n = 40)
IB: male fatteners, second GnRH vaccination at 18 weeks of age (n = 40)
EM: entire males, no study-related treatment (n = 40)
C: male fatteners, surgical castration at third day of life (n = 40)
SFA: saturated fatty acids
MUFA: monounsaturated fatty acids
PUFA: polyunsaturated fatty acids

The decrease in feed intake in week seven (18 weeks of age) in all groups but especially in group C can be explained with the movement activity they had during body weight measurement because of the long distance they had to walk between barn and scale and the unusual amounts of agitation in the stable. Surgically castrated pigs are less active than GnRH vaccinated until second vaccination (Baumgartner et al., 2010). Therefore the effect of activity that the pigs are not used to can be the reason why particularly group C had the biggest decrease in feed intake. This is why further body weight measurements were cancelled. In the planning of studies, especially under commercial production conditions, it has to be considered that events like repeated body weight measurement mean stress to the pigs that can influence the results of the study so that they do not represent the real situation.

In our study, no significant differences between the groups were found in carcass weight. This is found to be in agreement with other studies (Boler et al., 2012). Some authors refer to a lower carcass weight in spite of a better feed conversion rate of GnRH vaccinated fatteners in comparison to surgically castrated (Albrecht et al., 2012).

Differences in carcass quality between surgically castrated and GnRH vaccinated male fatteners like in our study were found in other studies as well (Schmoll et al., 2009; Gispert et al., 2010; Morales et al., 2010). No difference was found in lean meat or back fat thickness between the earlier (group IB) and later (group IA) vaccinated fatteners. This stands in contrast to results of Lealiifano et al. (2011), that found less back fat in fatteners that received second vaccination two weeks prior slaughter than in those vaccinated four weeks prior slaughter. It has to be considered that in their study the pigs were of another breed, older at second vaccination and fed a different diet than the pigs in our study.

Carcasses of GnRH vaccinated fatteners reached 5.97 € (group IA) and 3.77 € (group IB) higher sales proceeds than group C as well as lower estimated feed costs of 2.28 € per pig in group IA and 3.56 € per pig in group IB in comparison to group C. Since carcass weight did not differ, the benefit of sales proceeds in the vaccination groups was mainly due to the higher percentage of lean meat. Schmoll et al. (2009) found a cost benefit of GnRH vaccinated pigs around 13 € per carcass in comparison to surgically castrated, whereat some of this benefit was caused by higher carcass weight.

In our study, group EM reached the highest sales proceeds and had the lowest feed costs, while potential losses because of boar taint have to be considered. In 25% of the measured back fat samples of entire boars, androstenone concentrations of more than 1000 ng/g were estimated. Furthermore, it has to be taken into account that slaughter was timed, so all study pigs had to be slaughtered at one of the planned time points, although some of them were not yet heavy enough or some were too heavy, by then. The last fact occurred with two pigs of group IB and one pig of group EM causing penalties in payment. More sales proceeds could probably be earned when the pigs are slaughtered according to their body weight (Schmoll et al., 2009).

According to Wood et al. (2008), back fat thickness influences fatty acid composition. In addition, fatty acid composition is also affected by breed, feed composition (Bee, 2001), age and gender (Wood et al., 2008; Kouba and Sellier, 2011). This has to be considered if control of meat processing quality is desired. The influence of breed, feed and housing could be excluded in this study, because all study animals had the same conditions and were of same breed. Our study found a correlation between fatty acids and back fat thickness. The lower the back fat thickness, the higher were PUFA and the lower SFA and MUFA. It has to be considered that this was mostly due to the fact that the vaccination groups and EM had lower back fat than group C.

SFA were lower in group EM, but did not differ between vaccination groups and group C. In contrast, differences in SFA between GnRH vaccinated and surgically castrated males were detected by Pauly et al. (2009). This could be due to the different diet fed in their study. PUFA, on the other hand, were higher in the vaccination groups and EM than in group C. These findings are confirmed by other authors, although some differences in fatty acid composition were found in the literature depending on the location of sampling and if they used back fat or belly fat for their analysis (Pauly et al., 2009; Mackay et al., 2013). Desaturation index was higher in group EM than in the other groups. This index shows the step of desaturation of SFA to MUFA and is in some studies used as an indicator for stearoyl-CoA desaturase activity (Pauly et al., 2009), but it does not necessarily coincide with this enzyme. Among other influencing factors, a higher intake of PUFA with feed leads to a down regulation of this enzyme and thereby less PUFA in adipose tissue (Bee, 2001). Since all study pigs were fed the same diet, the overall feed intake has to be considered. Group EM had the lowest feed intake and the highest PUFA and desaturation index. The connection between feed intake and PUFA in back fat was described by Pauly et al. (2009) as well.

In some PUFA, differences were seen between the vaccination groups in our study. Since the percentages of those fatty acids are very low, the influence on meat processing quality or taste would be negligible. This is confirmed by the fact that other studies refer to no differences in meat quality (Gispert et al., 2010; Mackay et al., 2013; Sattler and Schmoll, 2013), processing quality (Font-i-Furnols et al., 2012) and taste (Font-i-Furnols et al., 2008) between GnRH vaccinated and surgically castrated males.

It can be concluded, that GnRH vaccination has a positive effect on lean meat, a decreasing effect on back fat thickness and feed costs compared to surgically castrated males. Fatty acid composition was shifted to higher PUFA percentage in back fat. Different time lags between second vaccination and slaughter had no effect on growth performance, feed intake and carcass quality. Some slight differences between both vaccination groups were only seen in PUFA and would not cause any effect on meat quality. Therefore, timing of second vaccination with Improvac® can be adapted within certain limits according to management procedures. GnRH vaccinated fatteners were economically superior to surgically castrated males in this study.

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