PE1.26 The Growth Performance of Male Pigs Vaccinated with the Boar Taint Vaccine, Improvac® and the Effects on Boar Taint Assessment 203.00

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***Abstract* – Two studies were conducted in China with the boar taint vaccine, Improvac. The first study was to assess the efficacy of the vaccine to suppress the boar taint compounds, androstenone and skatole and the subsequent effect on the sensory attributes of pork. The second study was to evaluate, under Chinese production conditions, the performance differences between physical castrates and boars vaccinated with Improvac.**

In the first study, the concentrations of androstenone and skatole in pigs treated with Improvac were not significantly different to those in the physical castrates and were lower than in non-castrated boars. When assessed using a consumer sensory panel, pork from pigs vaccinated with Improvac was judged to be of equivalent sensory quality to pork from physical castrates. In the second production study pigs vaccinated with Improvac demonstrated a higher feed efficiency, lower backfat and higher lean meat content compared to physical castrates. These results confirm that, under commercial production conditions, the use of Improvac vaccination to control boar taint enables vaccinated boars to demonstrate the superior feed efficiency, reduced back fat and increased lean meat yield percentage associated with non-castrated boars.

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***Index Terms*—Boar taint, castration, Improvac, growth, meat quality.**

I. INTRODUCTION

CHINA is the largest swine producer and pork consumer in the world. With the improvement of living standards, it is expected that Chinese consumers will have an increased demand for high quality, lean and safe pork. Thus the efficiency of production must be increased while respecting the environment and animal welfare. From this aspect the raising of intact male pigs is attractive. The natural growth factors in the intact male pig result in better feed efficiency and a leaner carcass compared with pigs that are physically castrated [1, 2]. However, pork from some entire male pigs may have an offensive odour, known as boar taint, which results in the pork being unacceptable to many consumers.

Currently, the usual method for controlling boar taint is physical castration. Improvac®, a vaccine to control boar taint, gives pig producers a powerful new alternative control method. By providing an environmentally and animal welfare friendly alternative, Improvac allows producers to benefit from the natural growth and carcass quality advantages of non-castrated male pigs while controlling boar taint. The objective of this study was to evaluate, under Chinese production conditions, the performance differences between castrates and boars vaccinated with the boar taint vaccine, Improvac (Pfizer Animal Health). Also, to assess the efficacy of the vaccine in suppressing the boar taint compounds, androstenone and skatole, and the subsequent effect on the sensory attributes of pork from boars vaccinated with Improvac compared to castrates and non-castrated boars.

V. MATERIALS AND METHODS

To demonstrate the efficacy and benefits of Improvac under commercial production systems in China two experiments were performed. The first was designed primarily to investigate the effects of vaccination on the boar taint compounds, androstenone and skatole, as well as the sensory attributes. The second was designed primarily to

assess the effects of vaccination on production characteristics as well as on the boar taint compounds androstenone and skatole.

a. *Experiment 1*

Animals: Four hundred male pigs were used, 80 castrates, 3 x 80 non-castrates with each group vaccinated with 1 of 3 production lots of Improvac (240 in total), and 80 non-vaccinated, non-castrate males. Male pigs within a litter were randomly assigned to castration, 1 of the 3 Improvac treatments or non-vaccinated boars. Castration was performed when the pigs were approximately 3-7 days of age using the normal practices for the farm. At weaning pigs were housed by treatment in pens of 8. Animals were weighed at intervals throughout the study. The 1st dose of Improvac was administrated at 15 weeks of age and the 2nd dose at 4 weeks prior to slaughter, or when 19 weeks old. Both doses were delivered behind the ear with a Secure Plus safety vaccinator and a 0.5 inch, 16-gauge needle. Blood samples were collected for testosterone analysis at the 1st dose and again prior to slaughter. At slaughter fat samples from the belly region of all pigs were collected for analysis of androstenone and skatole.

Pork for sensory assessment:

The right loins from 20 pigs per treatment were selected at random from the larger groups – 20 castrates, 3 x 20 boars vaccinated with the 3 production lots of Improvac (60 in total) and 20 non-vaccinated, non-castrate males. After slaughter, skinless boneless loins were collected and trimmed to a uniform fat cover of 3-5 mm. The loins were sliced into 12-15 mm thick steaks and stored overnight at 2-4^{o}C until used for the sensory evaluation.

Cooking: Samples were cooked on a single-sided electric hot plate set at approximately 190^{o}C for 2-3 minutes per side or until still just slightly pink and moist in the middle. Four samples from the same treatment were cooked at one time (4 panellists). Only loins from the same treatment were cooked at the same time so as to avoid cross contamination. Grills were washed in warm water between each cooking session.

Sensory assessment: 120 consumers were used with each panellist evaluating 5 samples in a session (one per treatment). There were 20 panellists per session. First a sample of fresh uncooked loin was presented to each panellist to assess the uncooked colour, odour and overall appeal. After assessment of the raw sample the pork was cooked and re-presented to assess the odour (prior to tasting), taste (flavour), tenderness, juiciness, and overall acceptance using a 10 cm line scale where 0 = dislike extremely to 10 = like extremely. The panellists were also asked to rate their intention to purchase each sample. Samples were presented in a fully blind and random manner. During the sensory evaluation the panellists were screened from each person immediately next to them. Panellists were briefed thoroughly on the questionnaires and test methodology prior to commencement and were only informed that they would taste different pork products, they were not informed of the treatments.

b. *Experiment 2*

A total of seven hundred and twenty male pigs were used across three replicates, 3 replicates of 120 castrates and 3 replicates of 120 vaccinated with Improvac. For each replicate at least 2 male pigs within a litter were randomly assigned to either castration or Improvac. Castration was performed when the pigs were approximately 3-7 days of age using the normal practices for the farm. At weaning pigs were housed by treatment in pens of 12. Animals were weighed at intervals throughout the study and feed use was recorded from weaning until slaughter at 22 weeks of age. The 1st dose of Improvac was administrated at 12 weeks of age and the 2nd dose at 5 weeks prior to slaughter, or when 17 weeks old. Both doses were delivered behind the ear with a Secure Plus safety vaccinator and a 0.5 inch, 16-gauge needle. At the end of the trial for each replicate all pigs were slaughtered at a commercial abattoir. For each replicate fat samples from the belly region of the median and next heaviest and the next lightest pig each pen of pigs (i.e. 3 pigs per pen for both treatments. In total 30 pigs per treatment per replicate) were collected for analysis of androstenone and skatole.

After slaughter the right loin was removed and cut transversly at the 10th rib. Backfat thickness was measured and the loin eye area measured in triplicate using a planimeter. Backfat and loin eye area were used to estimate lean meat yield using the following equation.

Lean meat yield = 40.056 - [0.036 × carcass weight (kg)] + [0.2625× loin eye area (cm^2)] - [3.170× backfat thickness at the 10th rib (cm)]

c. *Boar taint and testosterone analysis*

In both experiments the prime boar taint compounds, androstenone and skatole were analyzed in sub-cutaneous belly fat using validated assay systems. After extraction from fat, androstenone concentrations were determined by liquid chromatography/mass spectroscopy (limit of quantitation [LOQ] = 0.20 µg/g) and skatole by

HPLC-fluorescent detection (LOQ = 0.0187 μg/g). Samples below the LOQ were assigned one half the LOQ value for statistical analysis. Testosterone was analysed using LC/MS/MS (LOQ 0.10 ng/mL).

d. Statistics

Data was analysed using SAS Release 9.1.3 (SAS Institute, Cary, NC). In experiment 1 the primary efficacy variables were boar taint (skatole, androstenone) and testosterone. In experiment 2 the primary efficacy variables were feed efficiency, average daily gain, hot carcass weight, back fat and lean meat percentage. Secondary efficacy variable were skatole and androstenone levels in fat. In experiment 2, feed efficiency was calculated by pen as average feed intake divided by average daily gain. All hypothesis tests were carried out at the 0.05 level of significance (two-sided).

VI. RESULTS AND DISCUSSION

Experiment 1

A summary of results from experiment 1 is presented in Table 1. From weaning until slaughter the Improvac vaccinated pigs demonstrated a better average daily weight gain (ADG) than either the castrates (significant for 2 of the 3 lots of Improvac) or the non-castrated boars. The concentration of androstenone and skatole in belly fat was not significantly different between the physical castrates or the pigs vaccinated with Improvac. By contrast both skatole and androstenone were significantly higher in the non-vaccinated boars with 6.9% of the boars being above the skatole sensory threshold of 0.20 μg/g fat and 8.3% above the androstenone threshold of 1.0 μg/g.

For fresh pork there were no significant differences in the colour, aroma or overall liking between any of the 5 treatment groups including the non-vaccinated control boars. It should be noted that the mean scores for all fresh attributes were on the favourable end of the line scale indicating that overall the 5 treatments were very acceptable to the consumers in this panel. For the cooked pork attributes of appearance, aroma (smell), juiciness liking, juiciness, mouth-feel, chewiness, after taste and overall liking there were no significant differences between treatments with all 5 treatments scoring on the "acceptable" side of the 10 point line scale. For flavour there was a slightly higher score for 1 of the Improvac treatments and the castrate group compared to the other 2 Improvac treatments and the intact boars. This difference just reached significance at the 5% level. However, all 5 treatments scored on the acceptable side of the line scale. For intent to purchase there were no significant differences between any treatments. In the traits related to boar taint it is noteworthy that there were no differences for the attributes of aroma or smell or overall acceptability for the intact boars. This is an unexpected finding. However, when the levels of androstenone and skatole in the sub-sample of intact boars used for the sensory assessment were examined, by chance, only one boar had androstenone (1.169 μg/g) above the sensory threshold of 1.00 μg/g androstenone and no boars had skatole above the sensory threshold of 0.20 μg/g. The androstenone and skatole concentrations in all the castrate animals and all the animals in the 3 Improvac groups were also below the sensory thresholds thus accounting for the numerically similar sensory scores for aroma and overall acceptability.

Experiment 2

The results are presented in Table 2. From weaning until slaughter the Improvac vaccinates were significantly more efficient converting feed to gain than the castrates. Weight gain (ADG) before the 2nd dose of Improvac was better in the castrated pigs ($P<0.05$). However, following the 2nd dose of Improvac ADG was significantly higher in the vaccinated pigs. When ADG was calculated from weaning to slaughter there was no significant difference. Consequentially there was also no difference between treatments in live weight at slaughter or hot carcass weight. Back fat was significantly lower and lean meat yield significantly higher in the vaccinated pigs. The concentration of androstenone and skatole in belly fat was not significantly different between treatments.

VII. CONCLUSION

The efficacy of Improvac in controlling boar taint under typical commercial conditions in China was confirmed. In both experiments, the concentration of androstenone and skatole in pigs vaccinated with Improvac were not significantly different compared with the physical castrates. Improvac was as effective as physical castration in reducing boar taint to the sub-sensory levels found in castrates. Similarly, when assessed by sensory analysis, the efficacy of Improvac in controlling boar taint was

demonstrated. Pork from Improvac vaccinates was judged to be of the same eating quality as pork from physical castrates.

These studies also confirmed that, under commercial production conditions, the use of Improvac vaccination to control boar taint enables vaccinated boars to demonstrate the superior feed efficiency, reduced back fat and increased lean meat yield percentage associated with non-castrated boars.

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Table 1: Average daily gain (ADG), testosterone and the boar taint compounds skatole and androstenone in castrates, Improvac vaccinates and non-vaccinated control boars.

Criteria	Castrates	Improvac Lot 1	Improvac Lot 2	Improvac Lot 3	Boars
Testosterone (ng/mL) at 1st dose (15 wks)	0.056[a]	0.705[b]	0.546[bc]	0.678[b]	0.439[c]
Testosterone (ng/mL) prior to slaughter (23 wks)	0.050[a]	0.053[a]	0.093[a]	0.086[a]	1.369[b]
ADG (kg/day) from weaning to slaughter	0.79[ac]	0.83[b]	0.81[a]	0.84[b]	0.77[c]
Skatole in fat (µg/g)	0.040[a]	0.036[a]	0.043[a]	0.040[a]	0.080[b]
Number and % above skatole sensory threshold of 0.20 µg/g	0	0	0	0	5 (6.9%)
Androstenone in fat (µg/g)	ND	ND	0.107	ND	0.439
Number and % above androstenone sensory threshold of 1.0 µg/g	0	0	0	0	6 (8.3%)

Different superscripts within a row indicate statistical significance at P<0.02. ND = androstenone in all animals in that treatment below the limit of detection of 0.10 µg/g.

Table 2: Average daily gain (ADG), feed efficiency, live/carcass weight, lean yield, back fat thickness, and boar taint compounds skatole and androstenone in castrates and Improvac vaccinated boars.

Criteria	Castrates	Improvac
ADG (kg/day) from weaning to second dose at 17 weeks	0.75[a]	0.72[b]
ADG (kg/day) from second dose to slaughter at 22 weeks	1.02[a]	1.14[b]
ADG (kg/day) from weaning to slaughter	0.83	0.85
Feed efficiency (kg feed/kg gain) weaning to slaughter	2.32[a]	2.17[b]
Live weight at slaughter (kg)	113.7	115.78
Carcass weight (kg)	89.3	90.0
Lean meat yield (%)	55.9[a]	57.2[b]
Back fat 10th rib (mm)	24.0[a]	20.5[b]
Skatole in fat (µg/g) (sensory threshold = 0.20 µg/g)	0.056	0.059
Androstenone in fat (µg/g) (sensory threshold = 1.0 µg/g)	ND	ND

Different superscripts within a row indicate statistical significance at P<0.02. ND = androstenone in all animals in that treatment below the limit of detection of 0.10 µg/g.