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Boar taint, meat quality and fail rate in entire male pigs and male pigs immunized against gonadotrophin releasing factor as related to body weight and feeding regime☆

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ABSTRACT

The objective of this experiment was to compare the pork quality of entire male pigs and pigs immunized against GnRF (IC males) at both light (64.8 kg) and heavy (106 kg) liveweights and two feeding regimes (restricted at 2.5 times maintenance and *ad libitum*). There was no difference in objective measurements ($P > 0.05$) or eating pork quality ($P > 0.1$) between entire male and IC males. Fail rates were reduced by 9.1% and 12% for pork from IC males for quality grade ($P = 0.007$) and re-purchase intention ($P = 0.001$), respectively, compared to pork from entire males. Skatole ($P = 0.001$) and androstenone ($P < 0.001$) levels in belly fat were higher in entire male than IC male pigs. In addition, 37.5% of the light entire male pigs fed *ad libitum* showed skatole levels that exceeded the sensory threshold of 0.2 μg/g. This work confirms that immunization against GnRF is effective in eliminating boar taint and reducing pork quality fail rates by approximately 10% compared to pork from entire males.

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1. Introduction

The Australian pork industry prefers to produce entire male pigs as they have a better feed conversion and less subcutaneous fat deposition compared to physically castrated pigs (Channon, D'Souza, & Dunshea, 2016). However the occurrence of boar taint which can reduce pork eating quality is an issue when producing entire male pigs (Andersson et al., 1999; Babol & Squires, 1995; EFSA Scientific Panel on Animal Health and Welfare, 2004). Boar taint is an offensive smell and is primarily caused by the compounds skatole, androstenone and indole (Bonneau, 1982; Lundstrom & Zamaratskaia, 2006).

One way to eliminate boar taint is to immunize male pigs against gonadotrophin releasing factor (GnRF; immunocastrates). Immunization against GnRF involves immunization with an incomplete analogue of GnRF conjugated to a carrier protein in a low reactogenic-adjuvant system (Dunshea et al., 2001). It allows the pig to grow as an entire male until the second immunization against GnRF. Following the second immunization against GnRF the pig becomes more similar to a physical castrate and any boar taint substances present are progressively metabolized. Therefore, there are lower levels of skatole and androstenone in the subcutaneous fat (Channon & Warner, 2011; Dunshea et al., 2001).

Another suggested avenue to reduce the incidence of boar taint in Australia is to reduce the slaughter weight of pigs destined for the fresh pork market. There is a belief amongst some producers, processors and retailers in Australia that if entire male pigs are slaughtered at <90 kg liveweight (LW) then there is no need for either physical castration or immunocastration because the incidence of boar taint is negligible (D'Souza et al., 2011). However, an Australian survey by D'Souza et al. (2011) showed a high proportion of pork samples exceeded the sensory threshold detection level for androstenone (1 μg/g) and skatole (0.2 μg/g) regardless of slaughter weight (73 to 115 kg LW). In addition, there was a poor correlation between carcass weight and androstenone and skatole (D'Souza et al., 2011). Although skatole and androstenone concentrations have been examined in light and heavy slaughter weight pigs, objective measurements and eating quality of both entire males and immunocastrated males have not been determined together under Australian conditions.

In addition to improving pork quality the Co-operative Research Centre for High Integrity Australian Pork aims to reduce fail rates of pork to <10% through the implementation of an eating quality pathway (Channon & Warner, 2011). The boar taint issue facing the Australian pork industry is likely to result in higher fail rates in pork from entire male pigs, however as outlined above, an effective way to eliminate

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boar taint is by immunization against GnRF. This project aimed to investigate whether immunization against GnRF improved pork eating quality fail rates in male pigs.

Therefore, the objective of this experiment was to compare the pork quality of entire male pigs and pigs immunized against GnRF at both light and heavy LW's. The hypotheses were: i) that male pigs immunized against GnRF will have improved pork eating quality compared to entire males at both light and heavy slaughter weights and ii) immunization against GnRF will reduce pork eating quality fail rates compared to entire male pigs.

2. Materials and methods

2.1. Care of animals

The experimental protocol used was approved by the Department of Agriculture and Food Western Australia's Animal Research Committee and by the Animal Ethics Committee (Activity number 2-12-11). The animals were handled according to the Australian code of practice for the care and use of animals for scientific purposes (National Health and Medical Research Council, 2004).

2.2. Experimental design

A total of 64 Large White × Landrace × Duroc entire male and immunocastrated male pigs were used in this experiment. The experiment was a 2 × 2 × 2 factorial with the main treatments being: i) sex (entire males or immunocastrated males (IC males)); ii) initial LW (45.9 kg (light) or 78.3 kg (heavy)) and; iii) feeding regime (F, 2.5 times maintenance (restricted; E_m (kJ / d) = 444 kJ × $LW^{0.75}$, where E_m = energy maintenance) or *ad libitum*).

2.3. Animals

The allocation, housing, diets and feeding regime of the pigs used in this experiment have been described previously in Moore, Mullan, Kim, Payne and Dunshea (2016). They are briefly described again here. Twenty six days prior to the commencement of the experiment, 32 entire male pigs at 26 ± 3 kg LW (mean ± SEM) and 32 entire male pigs at 51 ± 3 kg LW were sourced from a high health status commercial herd. Due to housing constraints the experiment was conducted in 2 batches of 32. Upon arrival the pigs were individually identified with ear tags, weighed and stratified on their LW, with half the pigs from each weight group receiving a priming dose of anti-gonadotrophin-releasing factor immunological product (Improvac, Zoetis Australia, Rhodes, Australia). Seven days prior to the commencement of the experiment the pigs in each weight and priming dose groups were stratified on LW and randomly allocated to a feeding regime. The pigs were housed in individual pens with a space allowance of 2.52 m^2 in a naturally ventilated shed. Each pig had access to water *via* a nipple drinker. On day 0 all pigs received the experimental diet and the second dose of the anti-gonadotrophin releasing factor vaccine was given to the pigs who had received the priming dose of the vaccine on arrival. Diets were formulated to contain 13.5 MJ digestible energy (DE)/kg and 0.59 g standardized ileal digestible lysine/MJ DE. This met the nutrient requirements of entire males at 50 kg BW as determined from Moore, Mullan, Campbell, and Kim (2013) and Moore, Mullan, Kim and Dunshea (2016) and ensured that the nutrient requirements of all the pigs were adequately met. Feed intake for the *ad libitum* pigs and pig LW were measured weekly. The required quantity of the restricted diet was fed once daily. Four weeks after the diets were implemented the pigs were individually tattooed, removed from feed overnight and transported to a commercial abattoir (approximately 90 min transport time). The pigs were stunned using a carbon dioxide, dip-lift stunner set at 85% CO_2 for 1.8 min (Butina, Denmark). Exsanguination, scalding, dehairing and evisceration were performed using standard commercial procedures.

2.4. Skatole and androstenone analysis

A 20 g sample of belly fat was removed from the carcass 24 h after slaughter and frozen at −20 °C until analysis for skatole and androsentone concentrations (Frontage Laboratories Co., Ltd., Shanghai, China). Skatole concentration in belly fat was measured using high performance liquid chromatography – fluorescence detection (HPLC-FLD). The lower limit of quantification was 0.0034 μg/g. Androstenone concentration in belly fat was measured using high performance liquid chromatography with mass spectrometric detection (HPLC/MS/MS). The lower limit of quantification was 0.2 μg/g. Several of the androstenone samples were lower than the analysis detection level and these were defined as 0 for the purpose of the statistical analysis.

2.5. Objective measurements

The pH in the *Longissimus thoracis* (LT) was measured in the LT muscle between the 12th and 13th rib at 45 min and 24 h post-exsanguination using a portable pH/temperature meter (Cyberscan pH 300, Eutech Instruments, Singapore) fitted with a polypropylene spear-type gel electrode (Ionode IJ44, Ionode Pty Ltd., Brisbane, QLD) and a temperature probe. The pH meter was calibrated on two standards (pH 4.01 and 7.0) as per the manufacturer's instructions.

At 24 h post-slaughter a section of the LT muscle was removed from the left hand side of the carcass between the 12th and 13th rib. Drip loss was measured using a modification of the method described by Rasmussen and Andersson (1996). The muscle was cut to a 50 g cube then wrapped in netting and suspended in a sealed plastic container. The samples were stored for 24 h at 4 °C. The sample was then removed and gently patted dry to remove excess moisture before being re-weighed. Color (L*, a* and b*) was measured with a Minolta Chromameter CR-400 (Minolta, Osaka, Japan), using D65 illumination, a 2° standard observer, and an 8-mm aperture in the measuring head, standardized to a white tile after a bloom time of 10 min at room temperature (18 °C). An 80 ± 10 g sample was cut from the loin samples to measure cooking loss and shear force (Bouton, Harris, & Shorthose, 1971). The samples were frozen in individual bags. The bagged frozen samples were then suspended from a metal rack and placed in a water bath which had been pre-heated to 70 °C. The samples were cooked at 70 °C until an internal temperature of 70 °C was reached (approximately 30 min). After removal from the water bath, the samples were allowed to cool in iced water for 30 min, patted dry to remove excess moisture, and re-weighed before being refrigerated at 4 °C overnight. Cooking loss percentage for each sample was determined by dividing the difference in the raw and cooked weights by the weight of the raw pork sample. The cooked sample was then cut into five cross-section square samples (1 cm^2) parallel to the muscle fibres. Warner Bratzler shear force was measured using a Warner Bratzler shear blade fitted to a Lloyd Texture Analyser (TA-2, United Kingdom). A 50 g sample of LT muscle, trimmed of visible fat and skin, was used to determine the percentage of intramuscular fat *via* the Ankom method (extraction of crude fat using petroleum ether) (Silliker Australia, Sydney, Australia).

2.6. Pork eating quality assessment

A portion of the LT was obtained from each pig and was cut into four loin steaks of 25 mm thickness (a total of 240 loin steaks, 8 pigs/treatment). However, at the time of eating quality analysis, samples from four pigs were removed due to unforeseen circumstances (only six pigs used for the treatment IC male × restrict fed × heavy LW and seven pigs used for the treatments entire male × restrict fed × light LW and IC male × *ad libitum* fed × light LW), giving a total of 60 pigs. Panelists evaluated four loin steaks in each sensory session, requiring 60 consumers. The consumer sensory sessions were conducted at the University of South Australia, Adelaide, South Australia.

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