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PREDICTION OF BOAR TAINT RISK IN PORK FROM TWO PIG GENOTYPES USING PLASMA SEXUAL STEROID CONCENTRATION

B. Lebret[1*], A. Prunier[1]

[1] PEGASE, INRAE, Institut Agro, 35590 Saint-Gilles, France

* Corresponding author: benedicte.lebret@inrae.fr

I. INTRODUCTION

Avoiding surgical castration of male piglets improves animal welfare, because of the preservation of their physical integrity and because anaesthesia and analgesia procedures for castration only partially relieve pain [1]. Raising non-castrated compared with castrated males improves the efficiency of lean meat deposition, thus reducing the environmental impacts of pig farming, and improves carcass lean meat content [2]. However, the risk of boar taint that can induce consumer rejection of pork and pork products should be controlled. Boar taint is mainly due to androstenone (**A**), a testicular steroid whose content mostly depends on pig genotype and age/body weight (BW), and skatole (**S**), metabolized from tryptophan by gut bacteria and whose content depends mainly on feeding and husbandry factors [3]. Both compounds accumulate in fat along pubertal development. Various strategies can be set up at farm level to reduce the risk of boar taint, but can be focused on A since it may influence S catabolism, and since pig feeding and pen cleanliness, two major levers to reduce S concentration, can be easily activated on farms [4]. Plasma 17β-oestradiol and backfat A concentrations are highly correlated [5]. Therefore, we hypothesized that plasma concentration of steroids could be used to predict backfat A and that reducing age/BW at slaughter would reduce the risk of boar taint. Thus, we measured plasma testosterone and 17β-oestradiol concentrations at three physiological stages, and backfat A and S concentrations at slaughter, in two pig genotypes differing in their propensity to accumulate A and S in fat: Large White x Pietrain (**P**) and Large White x Duroc (**D**) crossbred males, and we used these measures to predict the risk of boar taint due to A at different BW.

II. MATERIALS AND METHODS

The experiment included a total of 81 non-castrated males, i.e. n = 47 D and n = 34 P in two successive batches (one pen per genotype and per batch) as detailed by Lebret et al. [6]. Briefly, pigs were raised in organic farming with indoor housing on deep straw bedding and access to an outdoor area. They were fed *ad libitum* with growing and finishing diets and had permanent access to grassland hay. Blood samples were drawn (heparinized tubes) on each pig from the jugular vein at three successive times during the finishing period: at around 85 kg BW and 133 d of age (stage 1; n = 77 pigs), 105 kg BW and 153 d (stage 2; n = 78 pigs) and the day before slaughter: around 125 kg BW and 174 d (stage 3; n = 80 pigs). Pigs were weighed individually on the day of sampling. Plasma was prepared and stored (-20°C) until analysis of 17β-oestradiol and testosterone using ELISA kits [7]. At slaughter (commercial slaughterhouse), a sample of backfat was collected (neck level), vacuum packaged and stored (-20°C) until analysis of A and S by HPLC [6]. All procedures were approved by the local committee on ethics in animal experimentation, and the experiment was authorized by the French ministry of higher education, research and innovation.
Statistical analyses were performed with R software. Age, BW, and plasma testosterone (after log transformation) and oestradiol (after square-root transformation) were analysed using an ANOVA with stage, genotype, batch and genotype x stage interaction as main effects and animal as a random effect. A and S concentrations were analysed using a non-parametric (Kruskall-Wallis) test because residuals could not reach a normal distribution. Spearman correlations between backfat A and S and plasma oestradiol and testosterone concentrations were calculated on raw data. The linear regression coefficient between plasma oestradiol at stage 3 and fat A was calculated (n = 80 pigs) using square root of data. Fat A was estimated from plasma oestradiol data (n = 235 samples) using the regression coefficient. Pigs were grouped in four categories according to their BW at blood sampling: < 85 kg, 85 to 105 kg, 105 to 125 kg, > 125 kg. In each category, the percentage of pigs above a threshold level of A for consumer rejection was calculated. Based on literature, two (more or less severe) A threshold levels were applied [3, 8].

III. RESULTS AND DISCUSSION

Plasma testosterone and 17β-oestradiol concentrations increased from the first to the second and from the second to the third sampling stage ($P < 0.05$) (Table 1). Plasma testosterone concentration did not differ between genotypes ($P > 0.1$) whereas plasma 17β-oestradiol was more than twice higher in D than in P pigs ($P < 0.001$) regardless of

age. D pigs had higher backfat A ($P < 0.001$) and S ($P < 0.05$) concentrations than P pigs. Plasma 17β-oestradiol concentration at stage 3 was highly correlated with backfat A (r = 0.91, $P < 0.001$). Estimating backfat A concentration from that of plasma oestradiol allowed to predict that reducing slaughter BW from more than 125 kg to less than 85 kg would reduce the percentage of carcasses with A concentration above 1.7 µg/g liquid fat (severe limit, [3]) from 37 to 14% in D pigs and from 10 to 0% in P pigs, and with A concentration above 3 µg/g (less severe limit, [8]) from 15 to 0% in D pigs, whereas none of the P pigs would be above this limit, regardless of age (Figure 1).

Table 1 – Influence of genotype and blood sampling stage on age, body weight, plasma hormones and slaughter backfat androstenone and skatole concentrations in non-castrated male pigs.

	Blood sampling stage			Genotype		*P*-value[1]		
	St. 1	St. 2	St. 3	D	P	Stage	Genot.	Batch
Age, days	133[a]	153[b]	174[c]	154	153	<0.001	0.59	0.93
Body weight, kg	83[a]	103[b]	127[c]	104	107	<0.001	0.73	0.24
Testosterone, ng/ml	1.3[a]	2.0[b]	2.9[c]	2.1	1.7	<0.001	0.14	<0.001
17-βoestradiol, ng/ml	14.0[a]	20.1[b]	26.4[c]	28.8	12.6	<0.001	<0.001	0.002
Androstenone, µg/g liquid fat[2,3]				1.32 (0.29 - 3.16)	0.60 (0.17 - 1.40)		<0.002	<0.004
Skatole, µg/g liquid fat [2,3]				0.02 (0.02 - 0.14)	0.02 (0.02 - 0.03)		<0.05	0.75

[1] P-values of the fixed effects of blood sampling stage, genotype and batch obtained from ANOVA. [a, b, c] lsmeans followed by different superscripts differed significantly (P < 0.01). [2] Determined on backfat samples taken the day after the 3rd blood sampling stage. [3] Median, and first and last decile values in brackets.

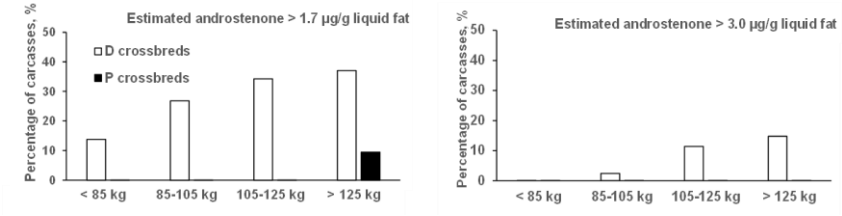


Figure 1. Percentages of carcasses with estimated backfat androstenone concentration above 1.7 µg/g liquid fat (left) or 3.0 µg/g liquid fat (right) in Large White × Duroc (D crossbreds) or Large White × Pietrain (P crossbreds) non-castrated male pigs, according to their BW

IV. CONCLUSION

D pigs had higher plasma 17β-oestradiol and backfat A concentrations than P pigs. Reducing slaughter age/BW is a major lever to reduce the boar taint risk related to A, especially in Duroc crossbred male pigs.

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