MEAT QUALITY, CARCASS COMPOSITION AND GROWTH OF PIGS TREATED WITH RECOMBINANT PORCINE GROWTH HORMONE

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SUMMARY

The effect of daily intramuscular injection of either 90 µg/kg body weight recombinant porcine growth hormone (pGH) or saline (0.9%) was tested on 12 crossbred boars and 12 crossbred gilts, starting at 48 kg live-weight. All pigs were transported and slaughtered on the same day in order to minimise the influence of pre-slaughter and slaughter handling on meat quality. The average live-weight of the pGH-pigs was 100 kg at slaughter, while it was 90 kg for the control pigs. The average daily gain during the treatment period increased 24% (from 0.84 to 1.04 kg/day), and the average feed conversion ratio decreased 16% (from 2.67 to 2.23 kg/kg) with pGH-treatment. At slaughter the P_2 fat thickness was 2.9 mm less for the pGH-treated pigs, and they increased their backfat thickness by only 1.8 mm compared to a 4.6 mm increase in control animals during the treatment period. The intramuscular fat content was unaffected by the treatment. There were no significant interactions between sex and treatment in any of the growth or body composition parameters. Treatment had no influence on either objective meat quality attributes (pH_{24h}, colour, drip loss, cooking loss and shear forces) or subjective meat quality (meat flavour, off-flavour, tenderness, juiciness and overall acceptability).

INTRODUCTION

Porcine growth hormone (pGH) has been found to influence the growth performance and carcass composition of finishing pigs (Henricson & Ullberg, 1960; Machlin, 1972; Chung et al., 1985; Etherton et al., 1986; Campbell, 1987; Etherton et al., 1987; Steele et al., 1987; Evock et al., 1988). In all these reports pGH administration resulted in increases in daily gain, better feed conversion, and much leaner carcasses. These responses were dose dependent. Etherton et al. (1986) found an increased response by dosage up to 70 µg/kg/day, while Beerman et al. (1988) found a maximum in growth performance at 60 µg/kg/day of either native or recombinantly derived pGH. A dose response experiment in Australia has shown that for maximum growth the daily dosage of recombinant pGH should be no more than 90 µg/kg (Seamark, personal communication).

The meat quality of these fast growing lean animals has only recently been studied. Beerman et al. (1988) found an increase in ultimate pH and a slight increase in shear force by increasing dose of native pGH. Also Bechtel et al. (1988) found a small increase in shear force by using native pGH, but no differences by using recombinant pGH. Evoch et al. (1988) found that neither native pGH nor recombinant pGH affected the sensory attributes of pork.

Here, we report on both objective and subjective attributes of meat quality of pigs treated with 90 µg/kg/day of recombinant pGH. Because the handling of pigs just prior to slaughter has a marked influence on pig meat quality all the animals in this study were killed on the same day rather than at the same liveweight.

MATERIALS AND METHODS

Twenty-four crossbreds (of Large White, Landrace, Berkshire and Wessex Saddleback) were kept in three pens of eight pigs each (4 entire males and 4 females). In the period between selection as weaners and application of the pGH-treatment, pigs were individually and restrictively fed a balanced grower diet calculated to contain 14.0 MJ digestible energy and 10.5 g available lysine/kg.

The pGH-treatment began when the mean liveweight of all pigs was 48 kg. Two males and two females from each pen were injected daily, with 1.1 ml of 90 µg/kg body weight recombinant pGH (Somatotropin, produced by Bresatec Ltd., Adelaide). The hormone was suspended in a sterile borate buffer (40 mM borate, 150 mM NaCl, pH 9.4) and the concentration was adjusted weekly according to the average body weight. The remaining control pigs were injected with 1.1 ml of physiological saline. All injections were intramuscular.

The composition (g/kg) of the diet fed to the pigs during the treatment period was: barley, 450; wheat, 360; soyabean meal (solvent - extracted), 100; fishmeal (tuna), 60; vegetable oil, 10; dicalcium phosphate, 10; L-lysine monohydrochloride, 15; sodium chloride, 2.5; vitamin and trace mineral premix (Williams et al.,1988), 5; spectinomycin (22mg/kg), 10. The diet was calculated to contain 13.5 MJ digestible energy and 8.9 g available lysine/kg. Pigs were individually fed a daily allowance based on live weight (90% of ad libitum intake) with adjustments being made after each weekly weighing. The P_2 backfat thickness was measured on live animals before the start of the treatment and before slaughter with Real Time Ultrasound (RTU; Ausonics 357, 7.5 MHz Transducer).

After 7 weeks of treatment, the pigs were transported, kept in lairage and then slaughtered in their separate pen groups. After their 1.5 hour transport period the pigs were rested for 3 hours in the lairage area before slaughter. The carcass P_2 fat thickness was measured with a Hennessy Grading Probe. After the carcasses had been chilled for 20 h at 2°C, the consistency of the subcutaneous fat was measured, at the last rib, with a sliding pin consistometer (Davey, 1983; Davey & Jones, 1985).

The M.longissimus dorsi (LD), M.semimembranosus (SM), and M.semitendinosus (ST) muscles, were removed from the right sides of the carcasses 20 h after slaughter.

Ultimate pH and Fibre Optic Probe measurements (FOP; TBL, Leeds, England) were taken on the three muscles. Objective meat colour, i.e. L, a and b values, were measured with a Minolta Chromameter on LD and SM muscles, after freshly cut surfaces had been exposed to air for 1 h. Drip loss was determined on a 100-130 g slice of LD, from the 13th rib, and on a 80-100 g slice of SM. The slices hung on hooks, in plastic bags, for four days in 2°C.

Samples (150-200 g) of LD, SM and ST were cooked in 80°C for 1 hour, and the cooking loss was determined. Warner-Bratzler shear forces and Instron compressions were determined on the cooked samples (Bouton and Harris, 1972). The intramuscular fat contents (IMF) of 3 cm slices of LD, taken from the last rib, and of 20 g samples of SM were assessed using Soxhlet diethyl ether extraction.

Sensory evaluation was performed on LD-samples, using a 15 member trained panel. Chops, 1.5 cm thick, with subcutaneous fat, were roasted in an oven of 200°C for 20 minutes. Meat flavour (none → strong), off-flavours (none → strong), tenderness (very tough → very tender), juiciness (very dry → → very juicy) and acceptability (very bad → very good) were all assessed on a nine-point scale (1 → 9).

To dissect the carcasses, the head and jowl, retro-peritoneal fat (flare fat), and trotters were removed and then the left side of each carcass was jointed into seven primal cuts; collar butt, picnic shoulder, tenderloin, loin, belly, rump and ham. Each cut was dissected into subcutaneous fat, intermuscular fat, lean, bone and connective tissue. All components were weighed and their weights expressed as percentages of the total weights of tissue recovered after dissection of sides. Skin thickness was measured with a ruler at the P_2-site.

RESULTS AND DISCUSSION

The effect of pGH on growth performance was immediate and pronounced; after one week the mean liveweight of pGH-treated pig was 1 kg greater than that of the control group. As can be seen from Table 1 the average daily gain (ADG), over the course of the

Table 1: Mean values and least significant differences (l.s.d.) for the growth parameters and carcass composition of pGH-treated (90 µg/kg/day) and control pigs.

Parameter	Treatment		l.s.d. (p=0.05)	Significance level[a)]
	Control	pGH		
Initial live weight(kg)	48.1	48.1	1.5	N.S.
Final live weight (kg)	89.8	99.7	3.5	***
Carcass weight (kg)	63.6	68.1	2.4	***
Average daily gain (kg)	0.84	1.04	0.05	***
Feed/gain	2.67	2.23	0.07	***
ΔP_2 (start to end; mm)	4.6	1.8	1.1	***
P_2 carcass fat depth (mm)	16.1	13.2	1.4	***
Carcass: Muscle %	52.7	58.3	2.8	***
" Fat %	30.9	24.0	2.5	***
" Connective tissue %	6.3	7.3	0.5	***
" Bone %	10.0	10.3	0.4	N.S.
Intramuscular fat LD (%)	1.2	1.1	0.3	N.S.
" SM (%)	2.0	2.1	0.6	N.S.
Eye muscle area (cm^2)	34.4	38.6	2.5	**
Skin thickness (mm)	3.5	4.1	0.4	**

a) Significance levels: $p \leq 0.05$*, $p \leq 0.01$**, $p \leq 0.001$***, N.S. = not significant

Table 2: Mean values and least significant difference (l.s.d) of the objective meat quality attributes of pGH-treated (90 µg/kg/day) and control pigs.

Measurement	Muscle	Treatment: Control	Treatment: pGH	l.s.d. (p=0.05)	Significance level[a)]
pH_{24h}	LD	5.58	5.56	0.08	N.S.
	SM	5.57	5.61	0.08	"
	ST	5.73	5.74	0.12	"
Colour (L)	LD	53.5	53.7	2.1	N.S
	SM	53.8	53.3	1.8	"
Colour (a)	LD	4.5	4.7	0.7	N.S.
	SM	7.0	6.7	1.2	"
Colour (b)	LD	4.4	4.5	0.6	N.S.
	SM	6.6	6.2	0.7	"
Fibre-optic-probe (FOP)	LD	23	23	3	N.S.
	SM	28	29	3	"
	ST	36	33	7	"
Drip loss (%)	LD	5.1	3.6	1.8	N.S.
	SM	4.9	3.3	1.4	*
Cooking loss (%)	LD	32.8	32.5	1.2	N.S
	SM	29.6	29.2	2.1	"
	ST	27.0	26.8	1.4	"
Peak shear force (kg)	LD	5.5	5.0	1.5	N.S.
	SM	6.2	6.5	1.5	"
	ST	3.8	3.6	1.8	"
Instron Compression (kg)	LD	1.39	1.44	0.23	N.S
	SM	1.72	1.75	0.21	N.S.
Fat consistency (N x 100)		13.5	12.0	2.5	N.S.

a) Significance levels $p \leq 0.05$*, N.S. = not significant

experiment, was 1.04 for pGH-pigs, and 0.84 kg for controls (a 23.8% increase in ADG). Steele et al. (1987) also found a 25% increase in ADG in pGH-treated pigs fed 80% of their ad lib intake.

pGH improved the feed conversion ratio by 16.5% (Table 1). This is a lower value than those of Steele et al. (1987), but similar to those found by Etherton et al. (1987).

Because of the differences in ADG, and the fact that all pigs were slaughtered on the same day, the mean live-weights of the two groups differed at slaughter by 10 kg (Table 1). Fat deposition was significantly affected by the treatment. The backfat thickness measured at the P_2-site on live animals increased only 1.8 mm on the pGH-pigs during the experiment, while it increased by 4.6 mm on controls. The carcass P_2 fat thickness, (Table 1) was 13.2 mm for pGH-pigs and 16.1 mm for controls (an 18% decrease).

The percentages of dissected muscle and fat in carcasses were 58.3% and 24.0% for pGH-treated pigs, and 52.7% and 30.9% for controls. Thus, the effect of pGH on lean/fat ratio was pronounced, 2.43 vs. 1.71 for controls. Of the reduction in fat deposition more than 76% occured in the subcutaneous depot. However, the intramuscular fat content of neither LD nor SM muscles differed between the two groups. The percentage of (dissected) connective tissue in the carcass was significantly greater for the pGH-treated pigs. This is probably due to the fact that the skin of pGH-treated animals was thicker (see Table 1). As can be seen from Table 1, the mean eye muscle area was significantly larger in pGH-treated pigs. The interactions between treatment and sex were not significant for any variable in Table 1, i.e. gilts and boars reacted similarly.

The results of the objective meat quality measurements are given in Table 2. No DFD meat (pH_{24} >6.0) or PSE meat (FOP>55) was observed. There were no significant treatment differences in colour, drip loss, cooking loss, shear force or Instron compression measurements. It was expected (Wood et al. 1986) that the subcutaneous fat of the leaner

Table 3: Mean taste panel scores and least significant difference (l.s.d.) of the sensory attributes of LD muscles of pGH-treated (90 µg/kg/day) and control pigs.

Attribute	Treatment		l.s.d. p=0.05	Significance level
	Control	pGH		
Meat flavour	5.0	5.1	0.6	N.S
Off-flavours	2.0	1.6	0.7	N.S
Tenderness	5.4	5.2	2.5	N.S
Juiciness	5.4	4.7	1.8	N.S
Acceptability	5.3	5.4	1.8	N.S

N.S. = not significant

pGH-treated pigs would be softer than that of the fatter control pigs, but no significant differences in fat hardness were found.

The trained taste panel found no significant differences due to the treatment for flavour, juiciness, tenderness or overall acceptability (Table 3). It is evident that none of the meat quality attributes measured, relevant for table, cured or processed meat, were affected by the treatment. The fact that the skin was thicker on treated animals could possibly have some influence on processed products which contain skin (eg. some sausages).

CONCLUSIONS

Porcine growth hormones had a marked influence on the growth rate, feed conversion and lean/fat ratio of the carcass, but it had no effect on any of the objective, or subjective meat quality attributes measured.

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