THE EFFECTS OF PROLONGED RELEASE PORCINE SOMATOTROPIN (pST) AND DIETARY PROTEIN LEVEL ON CARCASS YIELD AND MEAT QUALITY

S.D.M. JONES[1], A.L. SCHAEFER[1], A.K.W. TONG[1], T.R. KASSER[2], W. ROBERTSON[1] and L.L. HOLT[1]

[1] Agriculture Canada Research Station, Lacombe, Alberta, Canada
[2] Monsanto Agricultural Comp., St. Louis. MO, United States

INTRODUCTION

Porcine somatotropin (pST) has been demonstrably effective with respect to increasing carcass lean and reducing carcass fat content (Etherton, 1988; Bechtel *et al.*, 1988; Campbell *et al.*, 1989; McNamara *et al.*, 1991). To date, the majority of production and carcass data on the effects of pST has been collected, with notable exceptions (Knight *et al.*, 1991), in studies where the daily injected product was used. Given the management complications inherent in the use of daily injection systems, the use of a prolonged release product has therefore been pursued.

In addition to pST administration method per se, the efficacy of pST is also argued to be dependent upon animal nutrition (Evock *et al.*, 1988; Buonomo and Baile, 1991). Porcine somatotropin is demonstrated to cause an increase in protein synthesis (Hart and Johnson, 1986) as well as nitrogen retention (Wray-Cahen *et al.*, 1991). Therefore, the dietary protein and amino acid levels necessary to support pigs treated with pST is likely to be higher than untreated pigs (Easter, 1987; Newcomb *et al.*, 1988; Smith and Kasson, 1991). Therefore, the purpose of the present study was to investigate the efficacy of a prolonged release pST product on growth, carcass yield and pork quality in finishing pigs fed different levels of dietary protein.

MATERIAL AND METHODS

One hundred and eight Lacombe breed pigs (barrows and gilts penned separately) were used in the present trial. A recombinant porcine somatotropin product (Monsanto Agricultural Comp., St. Louis product #CP115409) formulated as two -12mg pellets to release 2mg rpST per day were implanted weekly into the base of the pigs ear at 70 kg±5 body weight. Control animals were sham injected.

Three isoenergetic diets (3.05MJ/kg) containing 14, 17, or 20% protein were *ad libitum* fed in the current study. The overall design was therefore 2 treatments x 3 diets x 2 genders x 3 animals per pen. The pigs were slaughtered at 105±0.3 kg. The minimum time on trial was 28 days. Animal weight gain and feed consumption was monitored throughout the trial.

All pigs were processed according to standard commercial procedures and all organ and carcass weights recorded. Carcass lean content was determined both by the use of a Hennessy Grading Probe (Hennessy Grading Systems, Auckland, New Zealand) and carcass cut-out procedures. Carcass fat content was assessed by both direct ruler measurements and by carcass dissection.

Meat quality assessment for muscle pH, moisture, fat content, temperature, drip loss, expressible juices, colour, structure, and shear force was determined according to methods published previously (Murray *et al.*, 1989). All quality assessment was conducted at the Meat Research Centre at the Lacombe Research Station. The analysis of all data was conducted using a general linear model (SAS, 1985).

RESULTS AND DISCUSSION

Prolonged release porcine somatotropin was seen to have no effect on growth performance in the present study (Table 1). However, the feed : grain ratio was reduced in the pST treated animals (P=0.07). Also, dietary protein level (Table 1) had no effect on average daily gain, feed intake or feed efficiency.

Porcine somatotropin as used in the present study had only minor effects on carcass characteristics (Table 2). There were no major differences in carcass lean content between pST and control animals. However, significant reductions in carcass fat were evident and most of the major organ weights were found to be higher in pST treated pigs.

Dietary protein was seen to cause several changes to carcass characteristics. In general, the dressing percent was lower in pigs placed on the higher dietary protein regime. However, fat thickness was reduced and carcass lean content increased in pigs given the higher dietary protein diets. For each 3% increase in dietary protein the carcass lean content increased by approximately 5g/kg. Kidney and liver weights were increased and kidney fat reduced in pigs placed on the higher dietary protein treatment (Table 3). The meat composition data generally demonstrated that bone content increased and fat content was reduced by pST treatment (Table 4).

In terms of meat quality, pST was found to cause several changes (Table 5). Principally, pST treated pigs displayed higher muscle pH and moisture content as well as a lower expressible juice and drip loss. In addition, the a* and b* coordinates (CIE system) were seen to be lower in pST treated pigs. Higher dietary protein was seen to be associated with lower marbling scores, less drip loss and a lower b* colour co-ordinate.

While pST was seen to have several effects on meat quality in the present study, the effects on carcass composition were modest in comparison to results from trials using daily injectable product. However, the results of the current study are for the most part consistent with those of Knight *et al.* (1991) where a six week implant was used. In all likelihood, the apparent discrepancies between the data obtained in studies using daily injection at the prolonged release product may arise from the fact that the prolonged release products fail to stimulate an episodic release pattern in pST peaks.

In contrast to the moderate effects on carcass composition, pST did cause several effects on muscle quality. Both initial and final pH levels were increased in pST treated pigs and a lower expressible juice and drip loss were also seen. Somatotropin also tended to reduce the intramuscular fat content and L* value as well as raise the moisture content which is consistent with the results reported by Boles *et al.* (1991). Therefore, pST may improve the processing value of pork (less drip loss).

Dietary protein effects were primarily evident by a reduced dressing percent, reduced fat thickness and increased carcass lean. Fewer effects of dietary protein level on muscle quality were seen with the possible exception of a reduced muscle drip loss and intramuscular fat.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance of Dr. G. Swenson, Monsanto Agricultural Company and to Monsanto Agricultural Company in general for provision of the pST product. We also wish to acknowledge the assistance of the Meat Research Centre and Piggery staff at the Lacombe Research Station.

REFERENCES

BECHTEL, P.J., EASTER, R.A., MCKEITH, F.K., NOVAKOFSKI, J., McLAREN, D.G., and GREBNER, G.L. 1988. Growth, carcass and sensory characteristics for pigs injected daily with natural porcine somatotropin. *Proceedings International Congress Meat Science and Technology* pp. 603-604.

BOLES, J.A., PARRISH, F.C.Jr., SKAGGS, C.L., and CHRISTIAN, L.L. 1991. Effect of porcine somatotropin, stress susceptibility, and final end point of cooking on the sensory, physical and chemical properties of pork loin chops. *J. Anim. Sci.* 69:2865-2870.

BUONOMO, F.C., and BAILE, C.A. 1991. Influence of nutritional deprivation on insulin-like growth factor. 1. Somatotropin and metabolic hormones in swine. *J. Anim. Sci.* 69:755-760.

CAMPBELL, R.G., JOHNSON, R.J., KING, R.H., and TRAVERNER, M.R. 1989(b). Advances in the manipulation of pig growth. Interactions between porcine growth hormone administration and dietary protein. In: FARRELL, D.J. (ed). *Recent Advances in Animal Nutrition in Australia.* University of New England. Armidale. p.141

EASTER, R.A. 1987. Nutritional Requirements and Repartitioning Agents. In: *The Pork Industry Conference.* University of Illinois, Urbana-Champaign. pp.193-199.

ETHERTON, T.D. 1988. Anabolic effects of porcine somatotropin on pig growth. In: *Designing Foods.* National Research Council, Wash. D.C.

EVOCK, C.M., ETHERTON, T.D., CHUNG, C.S., and IVY, R.E. 1988. Pituitary porcine growth hormone (PGH) and recombinant PGH analogue stimulate pig growth performance in a similar manner. *J. Anim. Sci.* 66:1928-1941.

HART, I.C., and JOHNSON, I.D. 1988. Growth hormone and growth in meat producing animals. In: BUTTERY, P.J., LINDSAY, D.B., and HAYNES, N.B. (eds). *Control and manipulation of Animal Growth.* Butterworths, London. pp.135-159.

KNIGHT, C.D., KASSER, T.R., SWENSON, G.H., HINTZ, R.L., AZAIN, M.J., BATES, R.O., CLINE, T.R., CRENSHAW, J.D., CROMWELL, G.L., HEDRICK, H.B., JONES, S.J., KROPF, D.H., LEWIS, A.J., MAHAN, D.C., McKEITH, F.M., McLAUGHLIN, C.L., NELSSEN, J.L., NOVAKOFSKI, J.E., ORCUTT, M.W., and PARRETT, N.A. 1991. The performance and carcass composition responses of finishing swine to a range of porcine somatotropin doses in a 1-week delivery system. *J. Anim. Sci.* 69:4678-4689.

McNAMARA, J.P., BREKKE, C.J., JONES, R.W., and DALRYMPLE, R.H. 1991. Recombinant porcine somatotropin alters performance and carcass characteristics of heavy weight swine and swine fed alternative feed stuffs. *J. Anim. Sci.* 69:2273-2281.

MURRAY, A.C., JONES, S.D.M., and SATHER, A.P. 1989. The effect of pre-slaughter feed restriction and genotype for stress susceptibility on pork lean quality and composition. *Cdn J. Anim. Sci.* 69:83-92.

NEWCOMB, A.L., GREBNER, M.D., BECHTEL, G.L., McKEITH, P.J., NOVAKOFSKI, J, McLAREN, D.G., and EASTER, R.A. 1988. Response of 60 to 100 kg pigs treated with porcine somatotropin to different levels of dietary crude protein. *J. Anim. Sci.* 66(Suppl.1):281.

SMITH, V.G., and KASSON, C.W. 1991. The inter-relationship between crude protein and exogenous porcine somatotropin on growth, feed and carcass measurements of pigs. *J. Anim. Sci.* 69:571-577.

STATISTICAL ANALYSIS SYSTEM INSTITUTE, INC. 1985. *SAS Users Guide.* Statistical Analysis Systems Institute Inc. Corp., NC.

WRAY-CAHEN, D., ROSS, A., BAUMAN, D.E., and BOYD, R.D. 1991. Metabolic effects of porcine somatotropin: Nitrogen and energy balance and characterization of the temporal pattern of blood metabolites and hormones. *J. Anim. Sci.* 69:1503-1514.

Table 1. Least squares means (±SE) of growth performance as affected by rpST or dietary protein level.

	Control	rpST	± SE	Pr
Average daily gain, kg d^{-1}	0.88	0.90	±0.01	0.459
Daily feed intake, kg	3.41	3.33	±0.04	0.369
Feed: gain	3.88	3.72	±0.03	0.069
Days on test (d)	36.3	35.6	±0.42	0.426
Initial weight (kg)	75.0	75.3	±0.28	0.690
Final weight (kg)	106.7	107.0	±0.32	0.585

	Protein Level[z]				
	14%	17%	20%	±SE	Pr
Average daily gain, kg d^{-1}	0.91	0.87	0.87	±0.02	0.626
Daily feed intake, kg	3.47	3.32	3.31	±0.06	0.487
Feed: gain	3.83	3.77	3.80	±0.06	0.487
Days on test (d)	33.1^{a}	37.2^{b}	37.5^{b}	±0.74	0.002
Initial weight, kg	77.8^{a}	75.5^{b}	72.2^{c}	±0.45	0.001
Final weight, kg	107.3^{ab}	107.7^{a}	105.7^{b}	±0.55	0.049

[z] Different superscripts are significant at $P<0.05$.

Table 2. Least squares means (SE) of carcass characteristics as affected by rpST or dietary protein level.

	Control	rpST	±SE	Pr
Warm carcass weight, kg	84.7	84.4	±0.42	0.513
Dressing pro-portion,g kg^{-1}	795	788	±0.42	0.050
Carcass length, cm	81.2	81.7	±0.53	0.241
Probe:				
Predicted lean (g kg^{-1})^y	486	488	±2.2	0.295
Fat thickness mm	22.2	21.2	±0.60	0.035
Muscle depth mm	39.7	36.8	±1.31	0.008
Actual:				
Carcass lean (g kg^{-1})^y	462	461	±4.0	0.785
Fat thickness mm	21.4	20.2	±0.003	0.042
Muscle depth mm	46.1	44.3	±0.039	0.047
Muscle width mm	80.4	80.7	±0.50	0.602
Ruler fat:				
Shoulder, mm	43.9	42.9	±0.58	0.256
10^{th} rib, mm	26.6	24.8	±0.87	0.011
loin, mm	29.1	28.9	±0.44	0.766
lumbar, mm	22.5	21.6	±0.48	0.197
Loin eye area cm^2	30.9	29.6	±0.38	0.014

Table 2 (cont). Least squares means (SE) of carcass characteristics as affected by rpST or dietary protein level.

	Protein Level^{z} 14%	17%	20%	±SE	Pr
Warm carcass weight, kg	85.5^{a}	85.4^{a}	82.8^{b}	±0.71	<0.001
Dressing pro-portion,g kg^{-1}	798.3^{a}	792.1^{a}	783.5^{b}	±3.61	<0.001
Carcass length, cm	81.7	81.4	81.2	±0.53	0.649
Probe:					
Predicted lean (g kg^{-1})^{y}	48.2^{a}	48.9^{b}	49.1^{b}	±0.39	<0.001
Fat thickness mm	23.2^{a}	21.1^{b}	20.8^{b}	±0.60	<0.001
Muscle depth mm	38.5	37.5	38.7	±1.31	0.625
Actual:					
Carcass lean (g kg^{-1})^{y}	45.6^{a}	46.2^{ab}	46.6^{b}	±0.90	0.030
Fat thickness mm	22.5^{a}	20.6^{b}	19.3^{b}	±0.87	<0.001
Muscle depth mm	45.3	44.7	45.7	±0.49	0.603
Muscle width mm	78.9^{a}	80.8^{b}	81.9^{b}	±0.86	0.050
Ruler fat:					
Shoulder, mm	45.0^{a}	43.5^{ab}	41.8^{b}	±1.01	0.007
10th rib, mm	26.7^{a}	25.7^{ab}	24.7^{b}	±0.87	0.083
loin, mm	30.4^{a}	28.8^{b}	27.9^{b}	±0.76	0.006
lumbar, mm	23.1^{a}	21.9^{ab}	21.0^{b}	±0.83	0.047
Loin eye area cm^2	29.9	30.3	30.8	±0.66	0.423

^{x} Values expressed as a proportion of live weight.
^{y} Values expressed as a proportion of warm carcass weight.
^{z} Different superscripts are significant at $P<0.05$.

Table 3. Least squares means (SE) of body component weight as affected by rpST or dietary protein level.

Component (g kg^{-1})^{y}	Control	pST	± SE	P
Tongue	0.23	0.24	0.03	0.469
Kidneys	0.37	0.40	0.01	0.007
Kidney fat	1.87	1.61	0.05	0.001
Heart	0.36	0.37	0.01	0.559
Liver	2.01	2.13	0.03	0.004
Spleen	0.19	0.18	0.01	0.537
Reproductive tract;bladder	0.63	0.62	0.03	0.732
Lungs;trachea	1.64	1.82	0.03	0.001
Full tract, alimentary	9.16	9.62	0.14	0.022
Blood	3.46	3.48	0.14	0.909

Table 3 (cont). Least squares means (SE) of body component weight as affected by rpST or dietary protein level.

Component (g kg^{-1})[y]	Protein level[z] 14%	17%	20%	SE	P
Tongue	0.23	0.24	0.24	0.006	0.461
Kidneys	0.35^{a}	0.39^{b}	0.42^{c}	0.011	<0.001
Kidney fat	1.84^{a}	1.80^{a}	1.57^{b}	0.078	0.001
Heart	0.35	0.37	0.37	0.01	0.114
Liver	1.97^{a}	2.06^{a}	2.18^{b}	0.05	<0.001
Spleen	0.18	0.20	0.18	0.02	0.596
Reproductive tract;bladder	0.62	0.65	0.59	0.05	0.447
Lungs;trachea	1.72	1.74	1.73	0.06	0.935
Full tract, alimentary	9.02^{a}	9.44^{ab}	9.69^{b}	0.24	0.024
Blood	3.76	3.20	3.46	0.24	0.075

[y] Expressed as a proportion on final live weight.
[z] Different superscripts are significant at $P<0.05$.

Table 4. Least squares means (SE) of carcass composition as influenced by rpST or dietary protein level.

Composition of cut (g kg^{-1})^{y}	Control	pSt	± SE	P
Picnic:				
Lean	579	579	3.9	0.990
Bone	91	98	1.2	<0.001
Fat	330	323	3.6	0.190
Butt:				
Lean	535	543	4.6	0.190
Bone	36	40	0.6	<0.001
Fat	428	416	4.7	0.080
Loin:				
Lean	470	472	3.8	0.680
Bone	136	144	1.8	0.001
Fat	394	383	4.3	0.080
Ham:				
Lean	578	580	3.5	0.750
Bone	94	106	0.9	0.008
Fat	328	323	3.5	0.320
Composition of lean cuts (g kg^{-1})^{x}				
Lean				
Bone	532	535	3.4	0.520
Fat (total)	100	106	1.0	0.001
	367	359	3.5	0.080

Table 4 (cont). Least squares means (SE) of carcass composition as influenced by rpST or dietary protein level.

Composition of cut (g kg^{-1})^{y}	Protein level^{z} 14%	17%	20%	SE	P
Picnic:					
Lean	569^{a}	585^{b}	584^{b}	6.7	0.032
Bone	94	93	96	2.1	0.414
Fat	337^{a}	322^{b}	320^{b}	6.3	0.026
Butt:					
Lean	528^{a}	537^{ab}	552^{b}	7.9	0.010
Bone	38	38	39	1.0	0.290
Fat	434^{a}	424^{ab}	409^{b}	8.1	0.008
Loin:					
Lean	456^{a}	471^{b}	486^{c}	6.7	<0.001
Bone	139	141	141	3.1	0.780
Fat	405^{a}	389^{b}	373^{c}	7.4	<0.001
Ham:					
Lean	574	579	583	6.1	0.370
Bone	95	95	97	1.6	0.200
Fat	331	326	320	6.1	0.200
Composition of lean cuts (g kg^{-1})^{x}					
Lean					
Bone	524^{a} 102	534^{ab}	534^{ab}	5.9	0.006
Fat (total)	374^{a}	103	104	1.7	0.430
		363^{ab}	352^{ab}	6.1	0.003

[x] Average composition of ham loin, butt and picnic.
[y] Composition of individual cuts.
[z] Different superscripts are significant at $P<0.05$.

Table 5. Least squares means (SE) of meat quality parameters affected by rpST or dietary protein level.

	Control	pST	± SE	P
pH (initial)	6.17	6.23	0.02	0.049
pH (24h)	5.51	5.57	0.01	0.002
Init'l carcass temp. (°C)	40.3	40.2	0.06	0.138
24h carcass temp. (°C)	1.8	1.8	0.03	0.405
Colour score	2.9	3.0	0.03	0.316
Structure score	3.0	3.0	0.02	1.00
Marbling score	6.7	6.6	0.15	0.543
Minolta: L* a* b*	 49.56 8.01 1.43	 49.12 7.61 0.85	 0.30 0.16 0.12	 0.302 0.089 0.001
Expressible juice, $g100g^{-1}$	23.05	20.75	0.53	0.003
Drip loss, $g100g^{-1}$	3.2	2.5	0.16	0.004
Shear value (kg)	5.6	6.0	0.13	0.062
Moisture, $g100g^{-1}$	73.3		0.11	<0.001
Intramuscular fat, $g100g^{-1}$	3.6		0.47	0.504

Table 5 (cont). Least squares means (SE) of meat quality parameters affected by rpST or dietary protein level.

	Protein level[z]				
	14%	17%	20%	SE	P
pH (initial)	6.20	6.20	6.20	0.04	0.982
pH (24h)	5.52	5.54	5.54	0.02	0.073
Init'l carcass temp. (°C)	40.4	40.2	40.2	0.11	0.087
24h carcass temp. (°C)	1.9	1.8	1.8	0.05	0.128
Colour score	3.0	2.9	2.9	0.05	0.174
Structure score	3.0	3.0	3.0	0.03	0.611
Marbling score	6.3^{a}	6.9^{b}	6.8^{b}	0.26	0.048
Minolta: L* a* b*	 49.65 8.04 1.50^{a}	 48.82 7.81 0.94^{b}	 49.54 7.58 0.99^{b}	 0.51 0.28 0.21	 0.221 0.261 0.014
Expressible juice, g100g^{-1}	22.48	21.84	21.38	0.93	0.492
Drip loss, g100g^{-1}	3.2^{a}	2.8^{ab}	2.4^{b}	0.28	0.019
Shear value, kg	5.7	5.9	5.8	0.23	0.633
Moisture, g100g^{-1}	73.4	73.5	73.8	0.19	0.146
Intramuscular fat, g100g^{-1}	3.9^{a}	3.3^{b}	3.3	0.81	0.023

[z] Different superscripts are significant at $P<0.05$.