DOSE RESPONSE EFFECTS OF NATIVE AND RECOMBINANT PORCINE SOMATOTROPIN (pST) ON GROWTH PERFORMANCE, COMPOSITION OF GAIN AND PORK QUALITY

D.H. Beermann, R.D. Boyd, G. Armbruster, A.F. DeNeergard, K. Roneker, T.D. Bartley and K.D. Fagin, Cornell University, Ithaca, New York and AMGen Co., Thousand Oaks, California, USA

INTRODUCTION

Turman and Andrews (1955) and Machlin (1972) first demonstrated the effects of exogenous administration of porcine somatotropin (pST) on growth performance and carcass composition in finishing swine. Using less pure pituitary extracts than are available today, they observed a 16% increase in rate of gain and 24% and 13% improvement in feed efficiency, respectively. Carcass protein was increased 20% and carcass fat was reduced 20%. Toxicity effects observed by Machlin, effects of impurities and scarcity of the purified hormone precluded continued active investigation.

Subsequent studies using recombinantly derived human somatotropin (Baile et al.1983) or pituitary derived pST (Chung et al. 1985) produced rather small responses, most likely attributed to use of suboptimal doses of somatotropin. Etherton and co-workers (1987) later observed in a dose response study marked improvement in growth performance, increased muscle mass (35%) and less carcass fat (18%) with 70 μg/kg pST administration for 35 days. Growth performance and metabolic responses did not plateau at the highest dose, however. Important questions left unanswered by these studies include the following: 1) What is the optimal dose for improving skeletal muscle growth and reducing fat accretion? 2) Does the same dose maximize growth performance? 3) What are the effects, if any, on pork quality and palatability?

Two studies were conducted at Cornell University to determine the extent to which highly-purified pituitary pST and recombinant pST enhance growth performance and composition of gain, and to determine if optimal dose differs among criteria. Portions of the results have been reported elsewhere (Boyd et al., 1986; Beermann et al., 1988).

EXPERIMENTAL METHODS

Experiment One

Highly-purified pituitary pST (provided by AMGen Co., Thousand Oaks, CA) was administered by daily subcutaneous injection at 0, 30, 60, 120 or 200 μg/kg body weight to 80 crossbred barrows and gilts from 45 kg to 100 kg live weight. Animals were individually housed and fed a concentrate diet fortified to contain at least 40% in excess of the nutrient requirements for optimal growth. Somatotropin dose was adjusted to live weight changes biweekly.

Animals were immobilized by electrical stunning and exsanguinated. Carcasses were chilled at 4C for 24 hours. Carcass measurements were made and two 2.54 cm loin chops were removed from the eleventh rib area and exposed to ambient air for 15 minutes before Gardner Color Difference Meter readings were taken. The chops were then vacuum packaged and frozen at -23°C. Subsequently chops were thawed overnight a 4°C and cooked at 165°C in a convection oven to an internal temperature of 70°C. Drip and evaporative cook loss was measured. Instron shear values were measured on ten 1.75 cm cores per chop using a Warner Bratzler blade assembly.

A cross-section of the longissimus was removed 24 hours postmortem and homogenized in 5 mM iodoacetate for pH determination. Semitendinosus and semimembranosus muscles were dissected, weighed, freeze dried and processed for proximate composition analysis. The remaining half-carcass was ground for proximate composition determination. The comparative slaughter technique was used to estimate composition of carcass gain. Half carcasses of six animals slaughtered at the initial live weight of treated animals (45 kg) were ground for proximate composition measurements.

Experiment Two

Seventy crossbred barrows and gilts were randomly assigned to receive 0, 30, 60 or 90 μg/kg body weight of 22 Kd or a 21 Kd variant form of recombinantly derived pST by daily injection (IM) from 45 kg to 105 kg live weight. Dose was adjusted biweekly. Slaughter technique, carcass chilling and carcass measurements were the same as in experiment one. Two loin chops were removed, vacuum packaged and frozen. One chop was used for Instron shear measurements, the other was used for sensory evaluation. Cooking methods and cook loss measurements were the same as in experiment one. Proximate composition of the longissimus was determined from a sample taken at the twelfth rib. Half-carcass proximate composition was also determined.

RESULTS

Experiment One

Optimal dose of pST differed with response criteria. Average daily gain was maximized (+15.8%) at 60 μg/kg, feed intake declined linearly (r = .98; -26% at 200 μg/kg)

TABLE 1. Dose Response Effects of Pituitary Derived pST on Carcass Composition and Composition of Carcass Gain.

	pST Dose (μg/kg body wt.)						Regression[a]	
Item	0	30	60	120	200	Sx	Linear	Quad.
Protein, %	14.7	15.9	17.0	18.1	18.8	.17	.01	.01
Water, %	49.6	52.6	56.4	60.3	62.8	.56	.01	.01
Lipid, %	32.1	27.7	21.6	17.2	13.8	.74	.01	.01
Ash, %	2.6	2.9	3.0	3.3	3.6	.25	.01	.06
Composition of Gain, g/d								
Protein	96	118	141	148	143			
Lipid	292	239	177	92	35			

[a]Regression response probability level.

and feed efficiency was improved 29.5% at 120 μg/kg pST. Effects of pST on carcass composition and composition of gain determined by comparative slaughter are presented in table 1 below.

The highest pST dose increased carcass protein percentage 28% and decreased lipid percentage 57%. The dynamic effect of pST on repartitioning nutrient use is best demonstrated by the composition of carcass gain data. Protein gain was increased 56% and lipid gain was reduced 88% with the 200 μg/kg dose. Although carcass weights were not affected by pST, weights and protein content of semimembranosus and semitendinosus muscles were increased 16% with the 120 μg/kg dose. Muscle lipid content and concentration (4.2%) was reduced 50% with the highest pST dose.

Instron shear values were not significantly affected by pST. Values were 3.17, 2.89, 3.59, 3.03 and 3.76 kg for the 0-200 μg/kg doses, respectively. Cooking loss was unaffected by pST. Ultimate pH of longissimus increased in a dose-dependent manner ($P < .002$) with pST treatment. Values were 5.33, 5.43, 5.44, 5.47 and 5.53 for the 0-200 μg/kg doses, respectively.

Although subjective color scores for the longissimus were not different among the treatment groups, Gardner Color Difference "Rd" and "a" values were significantly reduced by pST ($P < .001$). Values were lower in pigs receiving 60, 120 or 200 μg/kg doses.

Experiment Two.

The 21 Kd variant form of recombinantly derived pST was more effective than the 22 Kd form in reducing feed intake (31%) over the doses studied. Rate of gain was enhanced similarly by both forms (17-19%) and feed efficiency was improved 26-29%. The dose required to optimize growth performance (60 μg/kg) differed from that which maximized carcass changes (90 μg/kg). The 21 Kd variant was also more effective in reducing carcass lipid (9.04 kg vs 22.91 kg in controls and 11.18 kg with 22 Kd pST) and increasing carcass protein (14.24 kg vs 10.83 kg in controls and 13.91 kg with 22 Kd pST). Longissimus lipid concentration declined with increasing pST dose from 2.02% in controls to .74% with 90 μg/kg pST. Neither cooking loss nor Instron shear values were affected by pST dose or form. No dose response relationship or pST form effect was observed for sensory characteristics, which included flavour, aroma, juiciness, tenderness and amount of connective tissue.

DISCUSSION AND CONCLUSIONS

Exogenous administration of highly-purified pituitary derived or recombinantly derived pST markedly repartitions nutrient use toward greater skeletal muscle growth and less fat accretion in finishing swine. Optimum dose is dependent upon response variable. Rate of gain and feed efficiency changes are maximized at a lower dose than carcass and muscle composition changes. Interactions between diet and response to pST were not examined. However, diminished feed intake and improvement in rate of gain at the highest doses indicate that nutrient requirements were not being met for pigs treated with the highest pST doses despite receiving a diet fortified to contain at least 40% in excess of levels recommended for optimal growth in control animals. Lipid concentration of skeletal muscle was markedly reduced, but pork quality characteristics and palatability traits were not adversely affected by somatotropin treatment.

SUMMARY

Two independent studies were conducted to determine the dose response relationships between exogenous administration of porcine somatotropin (pST) and growth performance, composition of carcass gain and pork quality characteristics in finishing swine. Native and recombinantly derived pST maximized growth performance at a lower dose (60 mg/kg) than that which brought about the largest changes in carcass composition and composition of carcass gain. Intramuscular lipid concentration was also reduced in a dose dependent manner. Although objective measures indicated that pST produced a slightly lighter, less red color in the longissimus muscle, differences were not detected by subjective evaluation. Cooking loss and Instron shear values were not significantly affected by pST treatment in either study. Sensory characteristics of longissimus were not affected by dose or form of recombinantly derived pST.

REFERENCES

Baile, C.A., Della-Ferra, M.A. and MacLaughlin, C.L. (1983). *Growth* **47**:225.

Beermann, D.H., Armbruster, G., Boyd, R.D., Roneker, K. and Fagin, K.D. (1988). *J. Anim. Sci.* **65** (Suppl. 1): in press.

Boyd, R.D., Bauman, D.E., Beermann, D.H., DeNeergard, A.F., Souza, L. and Butler, W.R. (1986). *J. Anim. Sci.* **63** (Suppl. 1):218.

Chung, C.S., Etherton, T.D. and Wiggins, J.P. (1985). *J. Anim. Sci.* **60**:118.

Etherton, T.D., Wiggins, J.P., Evock, C.M., Chung, C.S., Rebhun, J.F., Walton, P.E., and Steele, N.C. (1987). *J. Anim. Sci.* **64**:433.

Machlin, L.J. (1972). *J. Anim. Sci.* **35**:794.

Turman, E.J. and Andrews, F.N. (1955). *J. Anim. Sci.* **14**:7.