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The Effect of Porcine Somatotropin Supplementation in Pigs on the Lipid Profile of Subcutaneous and Intermuscular Adipose Tissue and Longissimus Muscle[1,2,3]

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ABSTRACT: The effect of porcine somatotropin (pST) on the lipid profiles of adipose tissue and muscle was investigated. Sixteen crossbred barrows were injected daily with either 3 mg of pST or a placebo. After slaughter, total lipid and fatty acid composition of raw subcutaneous (SC) adipose and intermuscular (IM) adipose tissue and longissimus muscle were determined. The SC adipose tissue from pST-treated pigs had a 7.5% decrease in total lipid content; specific fatty acids 16:0, 18:0, and 18:1(*n*-9)c decreased most. The IM fat from pST-treated pigs had lower levels of 16:0 and 20:0. There was no effect of pST treatment on the lipid profile of the longissimus muscle. The data suggest that pST treatment produces small but significant changes in the saturated fatty acid content of adipose tissue in pigs.

Key Words: Pigs, Somatotropin, Fatty Acids, Lipids

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Introduction

The administration of exogenous porcine somatotropin (pST) to enhance growth and at the same time decrease fat accretion has been well established (Machlin, 1972; Etherton et al., 1986, 1987; Campbell et al., 1988, 1989a,b; Evock et al., 1988). However, the information available about the effect of pST treatment on the fatty acid profiles of porcine tissues is limited. Prusa et al. (1989a) and Lonergan (1992) showed an increase in the level of polyunsaturated fatty acids (PUFA). Such questions are of immediate interest because of the possibility of providing a product that closely fits current dietary guidelines.

Several health advisory committees recommend that consumers reduce their intake of total and saturated fat (AHA, 1986; USDA, 1990). Because the effect of pST on the fatty acid composition of pork and its products is not established, the manner in which pork from pST-treated pigs fits in with current dietary recommendations is unclear. The present study was conducted to investigate the effects of pST on the content of lipids and fatty acids in subcutaneous and intermuscular adipose tissue and longissimus muscle.

Materials and Methods

Sixteen commercial barrows of a meat-type crossbreed (Hampshire, Duroc, Berkshire, Spotted Poland) were obtained from Bischof Pig Farm, Sherwood, OR. The pigs were assigned according to weight to one of two groups, treatment or control. The weights at the beginning of the study for control and treated animals were 54.5 ± 2.2 kg and 53.9 ± 1.4 kg, respectively; their weights at the end of the study were 106.1 ± 2.0 kg and 106.1 ± 2.8 kg, respectively. The pigs were housed so that two pens contained control animals and two

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Table 1. Diet composition

Ingredient	Wt % of diet
Ground yellow corn	67.67
Soybean meal (47% CP)	25.60
DYNAFOS (phosphorus)	3.04
Limestone	.68
Salt	.40
Vitamin/mineral mix[a]	.25
Fat (beef tallow)	2.00
L-lysine·HCl	.36
Feed analysis[b]	
Moisture	15.13
Crude protein	17.65
Fat	4.05
Calcium	.63
Phosphorus	.84
Potassium	.71
Lysine[c]	1.15

[a]OSU Swine Premix, Shamrock, Inman and Co.; content per kilogram of mix: vitamin A, 1,322,751 IU; vitamin D_3, 440,917 IU; vitamin E, 441 IU; vitamin B_{12}, 4.4 mg; vitamin K, 882 mg; riboflavin, 1,764 mg; pantothenic acid, 3,245 mg; niacin, 8,818 mg; choline chloride, 110,229 mg; selenium, 40 mg; and ethoxyquin, 25.0 g.
[b]Analysis performed by Pitman-Moore, Inc., Terre Haute, IN.
[c]Analysis performed by Hazelton Laboratories, Inc., Madison, WI.

contained treated animals. The pens were constructed inside an unheated barn on the Oregon State University campus with wire fencing for barriers and cedar shavings for the floor. Both groups received daily injections. The treated pigs were injected with 1 mL of 3 mg of pST in buffer (.025 *M* $NaHCO_3$, .025 *M* Na_2CO_3) (Pitman-Moore, Terre Haute, IN). Control pigs were injected with 1 mL of the buffer only. The injection site was the subcutaneous adipose tissue posterior to the base of the ear and alternated from left to right sides daily. Treatments were given between 0930 and 1030. Approval to use swine for this study was obtained from Oregon State University's Animal Use and Care Committee.

All pigs had ad libitum access to feed and water. A corn-soybean meal-based diet (Table 1) was fed to both groups. Because an increase in lean tissue deposition was expected, and this increases the crude protein requirement, the diet was formulated to contain a high content of crude protein and lysine, the limiting amino acid. The lysine content was .6% in excess of the requirement of pigs from 50 to 110 kg (NRC, 1988).

The pigs were weighed and feed intake per pen was recorded weekly. Pigs were slaughtered when they reached market weight, an average value of 106 kg, ranging from 96 to 112 kg. All pigs were slaughtered at the Clark Meat Science Laboratory, Oregon State University.

After the carcasses were chilled for 48 h at 4° C, traditional measurements were collected. Data collected were live weight, chilled weight, carcass length, 10th rib backfat thickness, longissimus muscle area, color and marbling score of the longissimus muscle, dressing percentage, and percentage of carcass muscle. Hot carcass weight was estimated from a 3% increase in the measured chilled weight, a procedure routinely employed at the Meat Science Laboratory. Percentage of carcass muscle was estimated using the following equation: [10.5 + (.5 × hot carcass weight) + (2 × longissimus muscle area) − (14.9 × 10th rib backfat)]/hot carcass weight × 100 (Boggs and Merkel, 1990). The remaining measurements followed standard procedures in the industry (Boggs and Merkel, 1990).

After carcass traits were recorded, chops with the skin and backfat attached were cut from the 10th rib. Chops were individually wrapped in film-lined freezer paper, placed in freezer bags, and immediately stored at −20° C for intervals of ≤ 18 d before analysis was initiated.

The chops were dissected while partially frozen into subcutaneous (SC) adipose tissue, intermuscular (IM) adipose tissue, and longissimus muscle after removal from storage. One sample was completed before another was initiated, thereby minimizing exposure to air and potential for oxidation. The SC adipose tissue samples were taken from the two layers of adipose tissue directly beneath the skin. The IM adipose tissue samples were taken between the latissimus dorsi, longissimus dorsi, and longissimus costarum muscles. The longissimus dorsi muscle was trimmed of all outer fat and used as the muscle sample. All three tissue samples were frozen in liquid nitrogen and ground frozen in a kitchen blender (Cycle Blend Pulse-Matic 10, Osterizer, Milwaukee, WI). Ground samples were wrapped in foil, enclosed in freezer bags, and stored at −20° C for ≤ 24 h before analyses were performed.

Moisture was determined on the ground samples of SC adiposes tissue and muscle. Moisture in SC adipose tissue was determined following AOAC method 926.12 (AOAC, 1990). Moisture in the muscle was determined following AOAC method 950.46 (AOAC, 1990).

Fat was extracted from the ground samples of SC and IM adipose tissue and muscle following the method of Bligh and Dyer (1959) using methanol and chloroform. Total lipids were measured gravimetrically on an aliquot of the lipid extract.

A second aliquot of the fat extract was used to determine the fatty acid profiles in SC and IM adipose tissue and muscle. The fat extracts were methylated using 10% boron trichloride in methanol (Sigma Chemical, St. Louis, MO; Song and Wander, 1991). The resulting methyl esters

Table 2. Effect of porcine somatotropin (pST) on carcass traits

Measurement	Control Mean	Control SE	pST Mean	pST SE	*P*-value
Live wt, kg	106.1	2.0	106.1	2.8	.983
Hot carcass wt, kg (estimate)	80.6	1.2	77.6	2.1	.254
Chilled wt, kg	78.2	1.1	75.4	2.1	.264
Dressing, %[c]	76.0	1.7	73.2	1.5	.015
Longissimus muscle area (LMA), cm^2	28.1	2.4	31.7	1.2	.211
Carcass length, cm	77.4	.8	77.3	.7	.921
Backfat thickness, cm[d]	3.4	.3	2.2	.1	.001
Carcass muscle, %[c]	49.5	2.7	54.5	1.1	.005
Color score	3.0	.0	3.0	.0	1.000
Marbling score	1.3	.5	1.0	.0	.145

[a]Values are means ± SEM; n = 6.
[b]NS = not significant at $P < .05$.
[c]Dressing percentage = chilled weight/live weight × 100.
[d]Backfat thickness measured at the 10th rib.
[e]Carcass muscle percentage = ([10.5 + (.5 × hot wt) + (2 × LMA) − (14.9 × 10th rib backfat)]/hot wt) × 100.

were identified by comparison to authentic standards (Nu Chek Prep, Elysian, MN) using capillary column gas chromatography. The methyl ester of heptadecanoic acid (17:0) (Nu Chek Prep) was added before the extraction and used as an internal standard to determine the amounts of identified fatty acids. The use of an internal standard allowed data to be expressed in gravimetric units, a more useful form for the consumer, rather than relative weight percentage.

Data were analyzed for the statistical significance of pST treatment using SAS (1985). The effect of pST treatment on carcass traits, moisture, total lipids, and individual fatty acids was assessed using a two-tailed Student's *t*-test (Snedecor and Cochran, 1989). For color and marbling scores, the Wilcoxon rank sum test was used (Snedecor and Cochran, 1989). For all analyses, statistical significance was defined as $P \leq .05$.

Results

Carcass Characteristics. Because pigs were housed several to a pen, individual feed intake data were not obtained. The carcass traits for the animals are given in Table 2. There was no significant difference in live weight, hot weight, chilled weight, longissimus muscle area, carcass length, color score, or marbling score between the control and treated pigs. There were significant changes in dressing percentage, backfat thickness, and carcass muscle percentage. Dressing percentage decreased by 4%, backfat thickness decreased by 37%, and muscle percentage increased by 10% in pST-treated pigs.

Moisture. The percentage of moisture for the SC adipose tissue and raw muscle is given in Table 3. There was an insufficient quantity of tissue to determine the percentage of moisture in IM fat. Moisture increased by 24% in SC fat as a result of pST treatment. Treatment did not affect the moisture content of raw muscle.

Total Lipids. The content of lipids in SC and IM adipose tissue and longissimus muscle are given in Table 3. The pST treatment decreased the lipid content of SC adipose tissue by 7% but did not affect the lipid content of IM adipose tissue or raw muscle. The effect remained significant when the data were expressed on a dry weight basis (data not shown).

Fatty Acid Profiles. The fatty acid profile of SC adipose tissue is given in Table 4. Fatty acids are reported to two decimal places only to show those fatty acids present in small quantities and does not imply accuracy.

The content of the fatty acids 16:0 (palmitic) decreased by 13%, 18:0 (stearic) decreased by 17%, and 18:1(*n*-9)c (oleic) decreased by 11%. The fatty acids 16:0, 18:0, and 18:1(*n*-9)c together represent approximately 75% of the total fatty acids. The decreases in these fatty acids represented a 2.4-g change in 16:0, a 1.7-g change in 18:0, and a 3.5-g change in 18:1(*n*-9)c. Reflecting changes in individual fatty acids, total saturated fatty acids (SFA) decreased by 14%, total monounsaturated fatty acids (MUFA) decreased by 10%, and total PUFA were unchanged with treatment.

The fatty acid profile of IM adipose tissue is given in Table 5. The changes that occurred were similar to those that occurred in SC adipose tissue; however, there were fewer significant changes. With pST treatment, the content of 16:0 decreased by 11% and 20:0 (arachidic) decreased by 26%. This represented changes of 2.2 g for 16:0 and .05 g

Table 3. Effect of porcine somatotropin (pST) on the moisture and lipid content of tissues[a]

Tissue	Control Mean	Control SE	pST Mean	pST SE	*P*-value
	Moisture, g/100 g of wet tissue				
Subcutaneous adipose tissue	9.9	.4	12.3	.5	.003
Raw muscle	73.4	.5	73.6	.2	.709
	Total lipids, g/100 g of wet tissue				
Subcutaneous adipose tissue	81.8	.8	75.7	1.0	.0006
Intermuscular adipose tissue	77.5	1.0	75.6	2.2	.465
Raw muscle	2.6	.3	2.3	.2	.354

[a]n = 6; values are means ± SEM.

for 20:0. Total SFA decreased by 12%; total MUFA and total PUFA were unchanged.

Although there was a tendency for 16:0, 18:0, and 18:1(*n*-9)c to decrease in longissimus muscle, there was no significant effect of pST treatment on the fatty acid profile of this tissue (Table 6).

Discussion

The most notable change in carcass measurements was the decrease in backfat thickness. However, in two different studies Etherton et al. (1986, 1987) reported no change in backfat thickness in 30-d treatments of animals growing from 30 to 60 or 50 to 79 kg. Similarly, Chung et al. (1985) found no change in backfat thickness in slightly longer treatments (35 d) in 40- to 77-kg pigs. We initiated treatment when the pigs were approximately 54 kg and terminated it at approximately 106 kg; the length of the treatment averaged 52.5 d. Our data suggest that the effect of pST on backfat thickness may be dependent on the total dose administered and(or) that the response may be greater at later stages of the growth cycle. Campbell et al. (1988), however, reported a decrease in backfat thickness in the earlier phase of growth at a similar dose of pST. Regardless of the mediating mechanism, the final value for backfat thickness was still in the normal range (1.8

Table 4. Effect of porcine somatotropin (pST) on the fatty acid profile of subcutaneous adipose tissue (g/100 g of wet weight tissue)[a]

Fatty acid	Control Mean	Control SE	pST Mean	pST SE	*P*-value
14:0	.85	.04	.84	.01	.851
16:0	18.71	.44	16.36	.51	.006
16:1(*n*-7)	1.50	.08	1.67	.10	.199
18:0	9.56	.41	7.91	.22	.005
18:1(*n*-9)t	.36	.02	.34	.02	.544
18:1(*n*-9)c	30.77	.62	27.25	.65	.003
18:1(*n*-7)	3.18	.25	2.95	.11	.436
18:2(*n*-6)	10.93	.38	10.80	.23	.782
18:3(*n*-3)	.49	.02	.48	.03	.718
20:0	TR[b]	—	TR	—	—
20:1(*n*-9)	.65	.04	.57	.02	.075
20:2(*n*-6)	.44	.02	.42	.02	.606
20:4(*n*-6)	.20	.03	.18	.01	.519
SFA[c]	29.15	.83	25.14	.64	.003
MUFA[d]	36.45	.88	32.78	.79	.011
PUFA[c]	11.92	.40	11.86	.24	.885

[a]n = 6; values are means ± SEM; NS = not significant at $P < .05$.
[b]TR = trace.
[c]SFA (saturated fatty acids) = 14:0 + 16:0 + 18:0 + 20:0.
[d]MUFA (monounsaturated fatty acids) = 16:1(*n*-7) + 18:1(*n*-9)t + 18:1(*n*-9)c + 18:1(*n*-7) + 20:1(*n*-9).
[e]PUFA (polyunsaturated fatty acids) = 18:2(*n*-6) + 18:3(*n*-3) + 20:2(*n*-6) + 20:4(*n*-6).

Table 5. Effect of porcine somatotropin (pST) on the fatty acid profile of intermuscular adipose tissue (g/100 g of wet weight)[a]

	Control		pST		
Fatty acid	Mean	SE	Mean	SE	*P*-value
14:0	.88	.05	.81	.04	.241
16:0	19.46	.35	17.24	.66	.014
16:1(*n*-7)	1.49	.05	1.50	.10	.914
18:0	10.26	.49	9.05	.28	.056
18:1(*n*-9)t	.33	.01	.31	.03	.519
18:1(*n*-9)c	29.27	.45	27.11	.90	.058
18:1(*n*-7)	3.37	.46	3.30	.30	.896
18:2(*n*-6)	9.44	.42	9.84	.13	.385
18:3(*n*-3)	.45	.03	.41	.03	.324
20:0	.18	.01	.13	.00	.011
20:1(*n*-9)	.58	.04	.53	.02	.264
20:2(*n*-6)	.37	.02	.36	.01	.651
20:4(*n*-6)	TR[b]	—	TR	—	—
SFA[c]	30.69	.88	27.14	.91	.019
MUFA[d]	35.04	.83	32.70	1.10	.119
PUFA[c]	10.29	.42	10.63	.13	.461

[a]n = 6; values are means ± SEM; NS = not significant at $P < .05$.
[b]TR = trace.
[c]SFA (saturated fatty acids) = 14:0 + 16:0 + 18:0 + 20:0.
[d]MUFA (monounsaturated fatty acids) = 16:1(*n*-7) + 18:1(*n*-9)t + 18:1(*n*-9)c + 18:1(*n*-7) + 20:1(*n*-9).
[e]PUFA (polysaturated fatty acids) = 18:2(*n*-6) + 18:3(*n*-3) + 20:2(*n*-6) + 20:4(*n*-6).

to 4.6 cm or .7 to 1.8 in) for pig carcasses as reported by Boggs and Merkel (1990).

Although pST treatment has been shown repeatedly to increase longissimus muscle area (Machlin, 1972; Etherton et al., 1986, 1987; Evock et al., 1988; Campbell et al., 1988, 1989a,b), we measured no significant change. Many of the studies that reported an increase in longissimus muscle area, however, started with younger pigs, and when older pigs (more similar in age to the

Table 6. Effect of porcine somatotropin (pST) on the fatty acid profile of longissimus muscle (g/100 g of wet weight)[a]

	Control		pST		
Fatty acid	Mean	SE	Mean	SE	*P*-value
14:0	.03	.01	.02	.00	.208
16:0	.71	.10	.53	.06	.153
16:1(*n*-7)	.08	.01	.07	.01	.297
18:0	.33	.05	.24	.03	.146
18:1(*n*-9)t	.01	.00	.01	.00	.955
18:1(*n*-9)c	1.15	.17	.85	.10	.165
18:1(*n*-7)	.14	.02	.11	.01	.255
18:2(*n*-6)	.24	.02	.23	.02	.791
18:3(*n*-3)	.01	.00	.01	.00	.457
20:0	TR[b]	—	TR	—	—
20:1(*n*-9)	.02	.00	.02	.00	.296
20:2(*n*-6)	.01	.00	.01	.00	.924
20:3(*n*-6)	TR	—	TR	—	—
20:4(*n*-6)	.03	.00	.03	.02	.428
SFA[c]	1.08	.16	.80	.09	.150
MUFA[d]	1.39	.21	1.05	.12	.178
PUFA[c]	.29	.02	.29	.02	.843

[a]n = 6; values are means ± SEM; NS = not significant at $P < .05$.
[b]TR = trace.
[c]SFA (saturated fatty acids) = 14:0 + 16:0 + 18:0 + 20:0.
[d]MUFA (monounsaturated fatty acids) = 16:1(*n*-7) + 18:1(*n*-9)t + 18:1(*n*-9)c + 18:1(*n*-7) + 20:1(*n*-9).
[e]PUFA (polyunsaturated fatty acids) = 18:2(*n*-6) + 18:3(*n*-3) + 20:2(*n*-6) + 20:3(*n*-6) + 20:4(*n*-6).

pigs in our study) were used, the dose of pST used was much higher than the dose we used.

Dressing percentage is influenced by the contents of the stomach and intestines, by the degree of muscling, and by the degree of fatness. Heavily muscled pigs have higher dressing percentages than light pigs do and very fat pigs tend to have higher dressing percentages than lean pigs (Boggs and Merkel, 1990). The decrease in dressing percentage with pST treatment in our study may have been due to the decreased fat in these pigs, as suggested by the backfat thickness measurements. Other investigators have also reported a decrease in dressing percentage with pST treatment (Machlin, 1972; Evock et al., 1988). However, although dressing percentage was lowered, it was still in the normal range (68 to 77%; Boggs and Merkel, 1990) for pig carcasses.

Percentage of carcass muscle was increased with pST treatment but was also in the normal range (45 to 64%; Boggs and Merkel, 1990). Carcass muscle was estimated in our study as it was by Gardner et al. (1989), who also reported an increase in carcass muscle percentage with pST treatment.

Although pST treatment increased the percentage of moisture in SC adipose tissue, the moisture content of the longissimus muscle was not influenced. Other studies have shown an increase in the percentage of carcass moisture with pST treatment (Campbell et al., 1988, 1989a,b; Evock et al., 1988). These studies also showed an increase in muscle deposition and a decrease in fat deposition (or an increase in the percentage of carcass protein and a decrease in the percentage of carcass fat). The increase in moisture composition in SC adipose tissue from pST-treated pigs in our study was most likely due to a decrease in fat, so that the water and collagen (connective tissue) content of the fat was concentrated. Wood et al. (1989) studied fat composition of the backfat from pigs with varied thicknesses of backfat and found that the composition of the fat from leaner pigs had an increase in water and collagen content. Similar to our findings in muscle tissue, Pruse et al. (1989a) reported no change in the moisture content of raw rib chops from pigs treated with either 4 or 8 mg of pST per day that grew from approximately 45 to 100 kg.

Total lipids were decreased by pST treatment in SC but not in IM adipose tissue or longissimus muscle. Other studies have shown a decrease in the percentage of carcass fat (Etherton et al., 1986, 1987; Campbell et al., 1988, 1989a,b; Evock et al., 1988). Fat content in SC adipose tissue (defined as the two layers of backfat beneath the skin) in our study decreased from approximately 82 to 76% with pST treatment. Fat contents were lower than the USDA Handbook 8-10 value for total lipids in backfat of 88.69% (USDA, 1983). Moisture content, however, was also higher in our study (9.9% in control samples and 12.3% in treatment samples) than in USDA Handbook 8-10 (7.69%), which accounts for part of the discrepancy in total lipids. Additionally, our study measured total lipids in the backfat at one site (10th rib), whereas the data in handbook 8-10 are for the backfat in its entirety. In IM adipose tissue, the fat content was not affected by pST treatment. The control and pST fat contents of 77.5 and 75.6% in IM fat are similar to the fat content given for raw, separable fat in USDA Handbook 8-10, which lists total lipids at 76.71%. In our study, however, we sampled intermuscular fat at only one location and did not include total separable fat, as Handbook 8-10 does. Considering differences in sampling, the values for total lipids in SC and IM adipose tissue in our study seem reasonable.

In previous studies there has been a significant decrease in fat content with treatment of 4 and 8 mg of pST per day in raw longissimus rib chops (Prusa et al., 1989a) as well as several other raw muscle sites (triceps brachii, semimembranosus, semitendinosus, and biceps femoris) (Prusa et al., 1989b). However, the decrease in the total lipid content of longissimus muscle in our study was not statistically significant. Prusa et al. (1989a) reported a decrease in fat content from 2.9 to 2.1% in raw rib chops from pigs treated with 4 mg of pST daily that grew from 45 to 100 kg. This is similar to the decrease from 2.6 to 2.3% fat in raw longissimus muscle chops in our study. The fact that the change we observed was not significant could be attributed to the smaller pST dose injected in the present study.

In the few studies that have measured the fatty acid composition of pST-treated pigs, the fatty acid profile has been reported in terms of relative weight percentage. Lonergan et al. (1992) recently reported that adipose tissue composition from several sites was not significantly altered by pST treatment, with the exception of a lower concentration of oleic acid in belly fat in treated pigs. In contrast, Prusa et al. (1989a) using rib chops reported that pST-treated pigs had a greater percentage of unsaturated fatty acids. However, these studies reported their data as relative weight percentage, not as grams of a fatty acid found in 100 g of wet weight of tissue as we do. Expressed as relative weight percentage (data not shown), our results also indicate an increase in the PUFA content of SC and IM tissue and raw muscle. The limitation to expressing the data in this manner is that the values describe relative

changes but not absolute ones. Although in some circumstances it is important to know the content of one fatty acid relative to the other, the effect of pST treatment on pig tissues is more clearly understood if data are expressed in absolute terms. In our study a trend emerged across the tissue samples, although significant changes were most evident in the tissue with the highest fat content, SC adipose tissue. In this tissue, when data were expressed in absolute terms, there were decreases in the content of 16:0, 18:0, 18:1(*n*-9), total SFA, and total MUFA, but there was no change in PUFA. In IM fat there were decreases in 16:0, 20:0 and total SFA, and the decreases in 18:0 and 18:1(*n*-9)c approached significance (P = .06). In muscle, although 16:0, 18:0, 18:1(*n*-9)c, total SFA, and total MUFA all decreased, the changes were not significant.

In our study, the most important changes were the decreases in the amounts of 16:0, 18:0, and 18:1(*n*-9)c, because these three fatty acids account for nearly 75% of the total fatty acids. Also of interest is the fat that 18:2(*n*-6), a fatty acid that accounts for between 8 and 14% of the total fatty acids in these tissues, was unchanged with pST treatment.

Some investigators have concluded that the mechanism by which pST decreases fat content in pigs is the inhibiting of lipogenesis (Walton and Etherton, 1986; Walton et al., 1986; Etherton, 1988). Our findings of a decrease in total SFA (including 16:0 and 18:0), a decrease in MUFA (including 18:1(*n*-9)c), and no change in PUFA (including 18:2(*n*-6)) support this conclusion. One would expect a decrease in fat synthesis to lead to a decrease in the production of SFA and MUFA with little change in the amount of PUFA, because the majority of the PUFA in pig tissues are the dietary fatty acids, 18:2(*n*-6) and 18:3(*n*-3), and are not synthesized. However, it does not exclude an alternative explanation. The possibility of an increased turnover of storage lipids (at the level of triacylglycerol synthesis or hydrolysis) exists.

Implications

Porcine somatotropin decreased the total lipid content of subcutaneous adipose tissue. In addition, it decreased the saturated fatty acids, 16:0 and 18:0, without changing the content of the polyunsaturated fatty acid, 18:2(*n*-6), in both subcutaneous intermuscular adipose tissue. Current dietary recommendations suggest that the intake of total fat and saturated fatty acids be lowered. Thus, pigs treated with porcine somatotropin may provide the consumer with a food that can be part of a low-fat diet.

Literature Cited

AHA. 1986. Dietary guidelines for healthy adult Americans. Circulation 74:1465A.

AOAC. 1990. Official Methods of Analysis (15th Ed.). Association of Official Analytical Chemists, Arlington, VA.

Bligh, E. G., and W. J. Dyer. 1959. A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol. 37: 911.

Boggs, D. L. and R. A. Merkel. 1990. Live Animal Carcass Evaluation and Selection Manual (3rd Ed.). Kendall/Hunt Publishing, Dubuque, IA.

Campbell, R. G., N. C. Steele, T. J. Caperna, J. P. McMurtry, M. B. Solomon, and A. D. Mitchell. 1988. Interrelationships between energy intake and endogenous porcine growth hormone administration on the performance, body composition and protein and energy metabolism of growing pigs weighing 25 to 55 kilograms live weight. J. Anim. Sci. 66: 1643.

Campbell, R. G., N. C. Steele, T. J. Caperna, J. P. McMurtry, M. B. Solomon, and A. D. Mitchell. 1989a. Effects of exogenous porcine growth hormone administration between 30 and 60 kilograms on the subsequent and overall performance of pigs grown to 90 kilograms. J. Anim. Sci. 67:1265.

Campbell, R. G., N. C. Steele, T. J. Caperna, J. P. McMurtry, M. B. Solomon, and A. D. Mitchell. 1989b. Interrelationships between sex and exogenous growth hormone administration on performance, body composition and protein and fat accretion of growing pigs. J. Anim. Sci. 67:177.

Chung, C. S., T. D. Etherton, and J. P. Wiggins. 1985. Stimulation of swine growth by porcine growth hormone. J. Anim. Sci. 60:118.

Etherton, T. D. 1988. Mechanisms by which porcine somatotropin enhances pig growth performance. In: G. L. Steffens and T. S. Rumsey (Ed.) Biomechanisms Regulating Growth and Development. pp 245–250. Beltsville Symp. Agric. Res., May 3–7, 1987, Beltsville Agric. Res. Center, MD. Kluwer Academic Publishers, The Netherlands.

Etherton, T. D., J. P. Wiggins, C. S. Chung, C. M. Evock, J. F. Rebhun, and P. E. Walton. 1986. Stimulation of pig growth performance by porcine growth hormone and growth hormone-releasing factor. J. Anim. Sci. 63:1389.

Etherton, T. D., J. P. Wiggins, C. M. Evock, C. S. Chung, J. F. Rebhun, P. E. Walton, and N. C. Steele. 1987. Stimulation of pig growth performance by porcine growth hormone: Determination of the dose-response relationship. J. Anim. Sci. 64:433.

Evock, C. M., T. D. Etherton, C. S. Chung, and R. E. Ivy. 1988. Pituitary porcine growth hormone (pGH) and a recombinant pGH analog stimulate pig growth performance in a similar manner. J. Anim. Sci. 66:1928.

Garner, T. L., H. G. Dolezal, C. P. Foutz, B. D. Behrens, and F. K. Ray. 1989. Effect of porcine somatotropin and sex-class on pork carcass grade traits and cooking characteristics. pp 266–271. Oklahoma Agric. Exp. Sta. 1989 Anim. Sci. Res. Rep.

Lonergan, S. M., J. G. Sebranek, K. J. Prusa, and L. F. Miller. 1992. Porcine somatotropin (PST) administration to growing pigs: Effects on adipose tissue composition and processed pork characteristics. J. Food Sci. 57:312.

Machlin, L. J. 1972. Effect of porcine growth hormone on growth and carcass composition of the pig. J. Anim. Sci. 35:794.

NRC. 1988. Nutrient Requirements of Swine (9th Ed.). National Academy Press, Washington, DC.

Prusa, K. J., J. A. Love, and L. F. Miller. 1989a. Composition and sensory analysis of rib chops from pigs supplemented with porcine somatotropin (pST). J. Food Qual. 12:455.

Prusa, K. J., J. A. Love, and L. F. Miller. 1989b. Composition, water-holding capacity and pH of muscles of pigs supplemented with porcine somatotropin (pST). J. Food Qual.

12:467.
SAS. 1985. SAS/STAT™ Guide for Personal Computers (Version 6). SAS Inst. Inc., Cary, NC.
Snedecor, G. W., and W. G. Cochran. 1989. Statistical Methods (8th Ed.). Iowa State University Press, Ames.
Song, J., and R. C. Wander. 1991. Effects of dietary selenium and fish oil (maxEPA) on arachidonic acid metabolism and hemostatic function in the rat. J. Nutr. 121:284.
USDA. 1983. Composition of Foods, Pork Products, Agriculture Handbook 8-10. USDA Human Nutrition Information Service, Government Printing Office, Washington, DC.
USDA. 1990. Nutrition and Your Health. Dietary Guidelines for Americans (3rd Ed.). U.S. Department of Agriculture and U.S. Health and Human Services, Government Printing Office, Washington, DC.
Walton, P. E., and T. D. Etherton. 1986. Stimulation of lipogenesis by insulin in swine adipose tissue: Antagonism by porcine growth hormone. J. Anim. Sci. 62:1584.
Walton, P. E., T. D. Etherton, and C. M. Evock. 1986. Antagonism of insulin in cultured pig adipose tissue by pituitary and recombinant porcine growth hormone: potentiation by hydrocortisone. Endocrinology 118:2577.
Wood, J. D., M. Enser, F. M. Whittington, C. B. Moncrieff, and A. J. Kempster. 1989. Backfat composition in pigs: differences between fat thickness groups and sexes. Livest. Prod. Sci. 22:351.