Sensory, Physical, and Chemical Properties of Pork Loin Chops from Somatotropin-Treated Pigs of Three Stress Classifications

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ABSTRACT: Forty-eight pigs of three known stress classifications were injected daily with porcine somatotropin (pST; 4 mg/d) or placebo. The effects of pST and stress classification on the sensory, physical and chemical characteristics of loin chops were observed. Chops from pST-treated animals were less tender and juicy than chops from control animals. Positive stress classification also significantly decreased juiciness but had no effect on tenderness and flavor. A significant interaction was observed for initial juiciness and sustained juiciness between chops from pST and stress-positive pigs. Whereas chops from carriers and normal pigs showed a reduction in juiciness traits with the pST treatment, among stress-positive animals both initial and sustained juiciness were increased with pST treatment. Treatment with pST had no effect on the fat, protein, and moisture content of the longissimus muscle. Furthermore, stress classification had no effect on the fat and moisture content of the longissimus muscle, but protein content was significantly higher in loin chops from stress-positive animals. Chops from pST-treated animals had significantly higher maximum shear force values, required more energy to break the sample, and had higher yield point values than chops from control animals, but stress classification did not affect the shear force values significantly. Treatment of stress-susceptible animals with pST does not lead to an increased incidence of pale, soft, exudative meat and may improve juiciness attributes of chops from stress-positive animals. However, pST treatment of animals, in this trial, led to a reduction of juiciness and tenderness of pork loin chops.

Key Words: Somatotropin, Pork, Tenderness, Juiciness, Stress

Introduction

Recent consumer demand for lean meat has resulted in research to increase lean meat production. To accomplish lean pork production, research has focused on the use of growth hormone (porcine somatotropin, pST) to investigate its effects on growth rate, feed efficiency, and lean and fat contents. Research results are needed also to determine the effects of pST on the sensory attributes of pork products. Chung et al. (1985), for example, observed a decrease in fat and an increase in protein of pork carcasses of animals treated with pST. Mixed research results have been obtained for the sensory attributes of pork chops (longissimus muscle) from pigs administered pST during growth and development. Prusa and coworkers (1989) and Novakofski et al. (1988) found no significant effect of pST on the sensory properties of pork chops. However, Boles et al. (1991) reported a significant decrease in tenderness, juiciness, and flavor of pork chops from animals treated with pST. Another major question to be answered concerns the effect of pST on stress-susceptible swine and on the quality of pork from treated animals. Some researchers have reported an increase in pale, soft, and exudative (PSE) pork with the administration of pST at a level of 100 \( \mu \text{g} \cdot \text{kg}^{-1} \cdot \text{d}^{-1} \) to animals slaughtered at 90 kg (Solomon et al., 1989, 1990). Conversely, Boles et al.
(1991) determined no increased incidence of PSE pork from animals of normal and stress-susceptible types treated with pST. Because of these conflicting results we designed and carried out a study similar to our first study (Boles et al., 1991) to determine the effects of pST on stress-susceptible animals. The objective of this study was to determine the effect of pST and stress classification (PSE) on the palatability, proximate composition, and shear force values of pork loin chops.

Materials and Methods

Forty-eight Yorkshire-cross pigs (24 barrows and 24 gilts) were allocated to six treatment groups consisting of eight pigs (four barrows and four gilts) based on stress classification and porcine somatotropin (pST, 4 mg/d; Pitman-Moore, Terre Haute, IN) or placebo administration. The research trial consisted of two replicates based on availability of animals of the different stress classification genotypes within each litter. When possible, littermates were assigned to each treatment combination. Stress susceptibility class assignment was determined by halothane screening (Christian, 1974), creatine phosphokinase (Allen and Christian, 1976), and blood typing (Rasmusen and Patterson, 1971). The stress susceptibility classifications were as follows: stress negative, stress carrier, and stress positive. Each pig was injected in the neck once daily until taken off test, starting at a weight of 59 kg. Treatment with pST was terminated and individual pigs were slaughtered as they reached 109 kg. The average number of days on test for all pigs was 68.3. Pigs, after an overnight fast, were slaughtered at the Iowa State University Meat Laboratory. Longissimus muscle (LM) samples were collected 45 min after slaughter for determination of muscle pH (Warriss, 1982) to confirm stress classification. All the stress-positive animals had a 45-min pH of < 6.0, whereas the stress-negative and carrier animals had 45-min pH of > 6.0. After a 24-h postmortem chill (4°C), primal loins samples were obtained from one side, vacuum-packaged, and frozen at -29°C.

Sensory Evaluation of Loin Chops

The sensory panel consisted of 13 trained panelists. Panelists were trained to evaluate the sensory attributes of broiled chops for initial juiciness, sustained juiciness, initial tenderness, sustained tenderness, and cooked pork flavor (AMSA, 1978; Boles et al., 1991). Training consisted of presenting the panelists with samples of known juiciness, tenderness, and flavor. Triangle tests were also used to assess the ability of panelists to determine differences in juiciness, tenderness, and flavor.

Four pork chops (1.91 cm) were cut from the frozen primal loin, thawed for 24 h at 2°C, and cooked by placing the chops on broiler pans 10.2 cm from the heat source of an electric broiler (204°C). Chops were turned halfway (35°C) through cooking. The end-point temperature of doneness was 71°C. To achieve this end-point temperature, chops were removed from the broiler when the internal temperature reached 68°C, as determined by thermometers inserted into the center of each chop. Three cooked chops were sectioned into 1.27-cm cubes immediately after cooking, and these cubes were placed in preheated, individually coded, glass jars (44 mL). Panelists were seated in individual booths illuminated with red lights and had room-temperature water for clearing the palate between samples. Scoring of each sensory attribute by each panelist was accomplished by marking on a 150-mm line anchored 127 mm from each end, with the least intensity of juiciness, tenderness, or pork flavor on the left and the greatest intensity of juiciness, tenderness, or pork flavor on the right. The scores of each individual panelist were used for statistical analysis.

Proximate Analysis

Chops (1.91 cm) from the 10 to 12 rib section were vacuum-packaged and frozen for analysis. Before analysis the chops were thawed in a 4°C cooler for 24 h. The longissimus muscle was removed, minced in a Cuisinart™ food processor (Cuisinart, Norwich, CT) for 1 min, and subsequently used for proximate analysis. Moisture (vacuum oven drying), fat (Soxhlet ether extract) and protein (macro Kjeldahl) content of the longissimus muscle were obtained by following AOAC (1990) procedures used in the Iowa State University Meat Laboratory. The mean of three measurements was used for statistical analysis.

Warner-Bratzler Shear Force

One chop cooked with the chops for sensory analysis was cooled at room temperature for 1 h and three 1.27-cm cores were removed parallel to the muscle fibers for analysis on a Model 4500 Instron Universal Testing Machine (Instron, Canton, MA) equipped with computer and LabVantage DB Series IX software. The tensile Warner-Bratzler apparatus was used with a crosshead speed of 100 mm/min and a sampling rate of 10 points/s. The data collected were maximum load generated by the sample, energy to break the sample, and load at the first yield of the sample. The average of the three cores for each measure were used for statistical analysis.
Table 1. Subclass means for sensory values* of loin chops by porcine somatotropin (pST) treatment and stress classification

<table>
<thead>
<tr>
<th>Stress classification</th>
<th>pST treatment</th>
<th>Initial tenderness</th>
<th>Sustained tenderness</th>
<th>Initial juiciness</th>
<th>Sustained juiciness</th>
<th>Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Control</td>
<td>Control</td>
<td>77.9 ± 3.1</td>
<td>81.0 ± 3.2</td>
<td>59.1 ± 2.8</td>
<td>61.8 ± 3.0</td>
<td>75.5 ± 2.9</td>
</tr>
<tr>
<td>Negative pST</td>
<td></td>
<td>68.7 ± 3.1</td>
<td>69.4 ± 3.1</td>
<td>56.6 ± 2.8</td>
<td>59.8 ± 3.0</td>
<td>80.7 ± 2.8</td>
</tr>
<tr>
<td>Carrier Control</td>
<td>Control</td>
<td>83.4 ± 3.3</td>
<td>83.7 ± 3.4</td>
<td>62.2 ± 3.0</td>
<td>63.4 ± 3.2</td>
<td>78.7 ± 3.0</td>
</tr>
<tr>
<td>Carrier pST</td>
<td></td>
<td>64.2 ± 2.0</td>
<td>67.6 ± 3.4</td>
<td>47.4 ± 3.0</td>
<td>46.9 ± 3.2</td>
<td>78.7 ± 3.0</td>
</tr>
<tr>
<td>Positive Control</td>
<td>Control</td>
<td>70.7 ± 3.0</td>
<td>74.1 ± 3.1</td>
<td>45.1 ± 2.8</td>
<td>49.1 ± 3.0</td>
<td>76.0 ± 2.8</td>
</tr>
<tr>
<td>Positive pST</td>
<td></td>
<td>65.3 ± 4.2</td>
<td>66.3 ± 4.3</td>
<td>52.1 ± 3.8</td>
<td>51.9 ± 4.1</td>
<td>67.3 ± 3.9</td>
</tr>
</tbody>
</table>

*Least squares means and standard errors for sensory values based on score sheet with 0 = least intensity of juiciness, tenderness, or pork flavor; 150 = greatest intensity of juiciness, tenderness, or pork flavor.

Effect of pST was significant (P < .05).
Effect of stress classification was significant (P < .05).
Interaction between stress classification and pST was significant (P < .05).

Statistics

This study was analyzed as a 2 x 3 factorial arrangement. The two factors were the two pST treatments and three stress classifications. Sex condition was tested and had no significant effect on any of the measures, so the data were pooled across sexes. Analysis of all data was performed using the GLM procedure of SAS (1985a,b). Least squares means were calculated and are presented as such in the tables because one stress-positive animal died during transport to the slaughter facilities. Means separation was accomplished using the lsd procedure.

Results and Discussion

Chops from pST-treated pigs received significantly lower scores for initial and sustained tenderness and for sustained juiciness than did chops from control pigs (Table 1). The decreased initial tenderness suggests an increase in myofibrillar toughness in contrast to sustained tenderness, which represents connective tissue toughness (Szczesniak, 1986). In a study similar to the one reported herein, pork chops from pST-treated animals (4 mg/d) were not different from controls in juiciness, tenderness, or flavor (Prusa et al., 1989). Novakofski et al. (1988) and Kanis et al. (1988) also found no changes in sensory characteristics of pork chops between pST-treated and control animals. Boles et al. (1991), however, observed a decrease in tenderness, juiciness, and flavor when animals were treated with 4 mg/d of pST. In this study, there was an interaction between pST treatment and stress classification for initial juiciness and sustained juiciness (Table 1). Chops from pigs of the carrier classification had a greater reduction of initial juiciness and sustained juiciness with the pST treatment than those from pigs of the stress-negative classification, and chops from animals of the positive classification had an improvement in initial juiciness and sustained juiciness with pST treatment. Samples from pigs of the positive stress classification decreased (P < .05) in initial and sustained

Table 2. Subclass means* for proximate composition of loin chops from control and porcine somatotropin (pST)-treated pigs of different stress classifications

<table>
<thead>
<tr>
<th>Stress classification</th>
<th>pST treatment</th>
<th>Moisture, %</th>
<th>Fat, %</th>
<th>Protein, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Control</td>
<td>Control</td>
<td>72.2 ± .6</td>
<td>2.6 ± .8</td>
<td>23.5 ± .2</td>
</tr>
<tr>
<td>Negative pST</td>
<td></td>
<td>73.0 ± .6</td>
<td>1.2 ± .8</td>
<td>24.0 ± .2</td>
</tr>
<tr>
<td>Carrier Control</td>
<td>Control</td>
<td>71.6 ± .6</td>
<td>3.6 ± .8</td>
<td>23.4 ± .2</td>
</tr>
<tr>
<td>Carrier pST</td>
<td></td>
<td>72.2 ± .7</td>
<td>2.5 ± .8</td>
<td>24.4 ± .2</td>
</tr>
<tr>
<td>Positive Control</td>
<td>Control</td>
<td>72.3 ± .6</td>
<td>1.7 ± .7</td>
<td>24.9 ± .2</td>
</tr>
<tr>
<td>Positive pST</td>
<td></td>
<td>72.2 ± .8</td>
<td>1.9 ± .9</td>
<td>24.3 ± .2</td>
</tr>
</tbody>
</table>

*Least squares means and standard errors of the means for proximate composition of loin chops.
Effect of stress classification was significant (P < .05).
Interaction between stress classification and pST was significant (P < .05).
Table 3. Mean Warner-Bratzler shear force valuesa
of loin chops from placebo [control]-
and porcine somatotropin [pST]-treated pigs

<table>
<thead>
<tr>
<th>Source</th>
<th>Maximum load, kgb</th>
<th>Energy to break, kg/mm²</th>
<th>Load at first yield, kgb</th>
</tr>
</thead>
<tbody>
<tr>
<td>pST treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>3.73 ± .13</td>
<td>30.8 ± 1.3</td>
<td>3.59 ± .12</td>
</tr>
<tr>
<td>pST</td>
<td>4.14 ± .14</td>
<td>34.8 ± 1.3</td>
<td>4.00 ± .14</td>
</tr>
<tr>
<td>Stress classification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>3.84 ± .15</td>
<td>31.9 ± 1.5</td>
<td>3.63 ± .14</td>
</tr>
<tr>
<td>Carrier</td>
<td>3.97 ± .16</td>
<td>32.1 ± 1.7</td>
<td>3.66 ± .16</td>
</tr>
<tr>
<td>Positive</td>
<td>4.02 ± .16</td>
<td>34.1 ± 1.9</td>
<td>3.69 ± .19</td>
</tr>
</tbody>
</table>

aLeast squares means and standard errors of the means for Warner-Bratzler shear force values of loin chops.
bEffect of pST was significant (P < .05).

Juiciness and flavor but were not different for initial and sustained tenderness (Table 1). This
does not agree with results reported by Andersen et al. (1975), who found no differences between
chops from normal and PSE animals for juiciness. Nor does it agree with the results of Boles et al.
(1991), who saw a significant reduction in tenderness in chops from stress-positive animals, but no
change in juiciness and flavor.

Treatment with pST did not significantly affect the proximate protein, fat, and moisture composi-
tion (Table 2) of raw pork chops, although differences were in the direction of results reported
earlier (Etherton et al., 1986; Prusa et al., 1989; Boles et al., 1991). These researchers observed a
decrease in lipid and an increase in moisture in pigs treated with pST. Loin muscles from stress-
positive pigs were higher in percentage of protein than were those of either the stress-negative or
stress-carrier groups. Fat and moisture contents were unaffected by stress classification. No treat-
ment × stress classification interaction was observed in moisture or fat content. The treatment × stress
classification interaction, however, was significant for protein (Table 2). Treatment of animals
from the negative and carrier classification with pST increased the protein content in the loin chop,
but animals from the stress-positive classification treated with pST had lower protein content (Table
2).

Chops from pST-treated animals had significantly higher Warner-Bratzler shear force values
for maximum load of the sample, energy to break the sample, and first yield point of the sample than
did chops from control animals (Table 3). The higher values for first yield are consistent with the
observed lower initial tenderness of chops from pST-treated pigs. The higher energy to break the
sample corresponds to the lower sustained tenderness scores. Warner-Bratzler shear force values
provide added evidence that treatment of pigs with pST reduces the tenderness of pork chops.
Stress classification of pigs had no significant effect on the Warner-Bratzler shear force values of
chops from these animals (Table 3).

In summary, broiled pork chops from pST-supplemented pigs had reduced sensory values for
initial and sustained tenderness and for sustained juiciness. Chops from stress-positive animals had
reduced initial and sustained juiciness values. Although pST reduced palatability attributes, the
differences were small. There was a significant interaction between pST treatment and stress
susceptibility of pigs for initial and sustained juiciness. Chops from pigs of the carrier classification
showed a greater reduction of initial juiciness and sustained juiciness with the pST treatment
than did chops from pigs of the stress-negative classification. Chops from animals of the positive
classification showed an improvement in initial juiciness and sustained juiciness with pST treat-
ment, suggesting that pST treatment of stress-positive pigs may improve the juiciness of chops
from these animals. Warner-Bratzler shear force values were higher for chops from animals treated
with pST. This suggests that there is a decrease in the tenderness of these chops. These results
suggest that pST treatment did not cause an increased incidence of PSE in stress-susceptible
animals. But, there was a small, significant decrease in the palatability of the chops from
animals treated with pST.

Implications

The use of porcine somatotropin can lead to the production of leaner, more muscular animals at
heavier slaughter weights. The use of porcine somatotropin, however, may result in reduced
tenderness and juiciness and may increase the incidence of pale, soft, exudative pork. In this
study, no increase in pale, soft, exudative pork was observed with the use of porcine
somatotropin, but treatment of animals with somatotropin significantly reduced the sensory
scores for juiciness and tenderness of broiled loin chops. These results suggest that somatotropin
treatment does not cause an increased incidence of pale, soft, exudative pork, although,
somatotropin of animals may result in reduced tenderness of pork chops.

Literature Cited

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