SENSORY AND PROCESSING PROPERTIES OF CURED SEMIMEMBRANOSUS MUSCLE FROM STRESS-SUSCEPTIBLE PIGS TREATED WITH PORCINE SOMATOTROPIN

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ABSTRACT

Forty-eight Yorkshire cross pigs of three stress susceptibility classes (stress positive, stress-carrier, and stress negative) were injected daily with porcine somatotropin (pST; 4 mg/d) or placebo. Each pig was injected in the neck once daily until taken off test, starting when the pigs weighed 59 kg. Porcine somatotropin treatment was terminated at weekly intervals as individual pigs reached 109 kg, but animals continued to be fed for six additional days to allow for required withdrawal time. The effect of pST and stress classification on the sensory, physical, chemical, and processing characteristics of cured semimembranosus (SM) muscle was evaluated. Treatment of animals with pST had no effect on the sensory scores, lipid and protein content, cooking yields, or color values of SM muscle slices. Semimembranosus muscles from stress-positive animals, however, had reduced sensory scores for texture, flavor, and overall palatability. Semimembranosus muscles from stress-positive pigs also had smaller cooking yields and greater Hunter a and b values of processed slices. The greater Hunter a and b values suggested that the color of these slices were redder and yellower than the color of SM muscle slices from negative and carrier animals. Semimembranosus muscles from stress-susceptible animals also had a significantly lower lipid content. Treatment of animals with pST did not significantly alter sensory, chemical, or processing characteristics of SM muscle slices from these animals.

Key Words: Somatotropin, Pigmeat, Stress, Processing, Sensory Evaluation


Introduction

Consumer demand for lean meat has caused the pork industry to investigate new ways of producing leaner pork. Recent research has focused on the use of growth hormone (porcine somatotropin, pST) to increase growth rate, improve feed efficiency, and reduce carcass fat. Chung et al. (1985), for example, have observed decreased carcass fat and increased protein in animals treated with pST. The use of growth promotants can lead to increases in lean meat and more efficient production (Baile et al., 1983; Etherton et al., 1986). Some researchers, however, have seen an increase in the incidence of pale, soft, exudative (PSE) meat with the injection of exogenous growth hormone (Solomon et al., 1989, 1990). Pale, soft, exudative muscle is usually associated with stress-susceptible animals (Tope1 et al., 1975; Cheah et al., 1984) and leads to decreased processing yields (Merkel, 1971). Miller et al., (1989) observed that muscle from pST-treated animals, when marinated and vacuum tumbled, had higher purge losses and lower cooking losses than control samples. They concluded from their observations that pST treatment may significantly affect the processing properties of fresh ham muscle. Because of the suggested PSE problem plus unanswered questions about processing characteristics, processors are concerned about the effect of pST on the processing and palatability characteristics of

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muscle from pST-treated animals. Consequently, research is needed to answer some important questions about the palatability attributes and processing characteristics of hams, especially hams from pST-treated, stress-susceptible pigs. The objective of this study was to determine the effect of pST and three stress classifications on sensory and processing characteristics of SM muscles.

Materials and Methods

Forty-eight Yorkshire-cross pigs (24 barrows, 24 gilts) were allocated to six treatment groups consisting of eight pigs (4 barrows, 4 gilts) based on stress classification and pST (4 mg/d) or placebo administration. The research trial consisted of two replicates, 24 animals each, based on availability of animals of the different stress classification genotypes within each litter. When possible, littersmates were assigned to each treatment combination. Stress susceptibility class assignment was determined at approximately 60 d of age by halothane screening (Christian, 1974), creatine phosphokinase activity (Allen and Patterson, 1971), and blood typing (Rasmusen and Christian, 1976). 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 was terminated at weekly intervals as individual pigs reached 109 kg, but animals continued to be fed for six additional days. A withdrawal time of 7 d was required by the Food and Drug Administration at the time of this study when the tissue was to be used for human consumption. The average time on test for all pigs was 68.3 d. Pigs, after an overnight fast, were slaughtered at the Iowa State University Meat Laboratory. Longissimus muscle samples were collected 45 min postslaughter for determination of muscle pH (Warriss, 1982) to confirm stress classification (Table 1). Color was also determined in the loin muscle 24 h postmortem, using the National Pork Producers Council color standards to help confirm stress classification (Table 1). All of the stress-positive animals had a 45-min pH of less than 6.0 regardless of pST treatment and a pale color, whereas the stress negative and carrier animals had 45-min pHs of more than 6.0 and a darker color. After a 24-h postmortem chill (0 to 1°C), semimembranosus (SM) muscles were obtained from right sides and all visible fat was removed. The SM muscle was used because it is a major muscle of the ham and to reduce variability seen between muscles. The muscles were then vacuum-packaged and frozen at -29°C.

Processing. Semimembranosus muscles were thawed at 2°C for 48 h and were injected with brine to a target of 25% (actual average 22%) of original weight using a Townsend 1400 injector (half stroke, 103.4 KPa). The brine contained 80% water, 11.0% salt, 6.6% sugar, 2.2% phosphate, .06% sodium nitrite, and .22% sodium erythorbate. Raw and pumped weights were recorded. Because identification of individual muscles was necessary, samples were not tumbled. Thus, SM muscles were submerged in brine and allowed to equilibrate for 4 d. After equilibration, SM muscles were removed from the brine, allowed to drain for 2 min, and weights were again recorded. Individual muscles were then stuffed into casings and thermally processed and smoked in an Maurer thermal processing unit. The first step in the cooking process was 45 min with the dry-bulb temperature at 82°C, followed by 15 min drying at 82°C. The next step was a 45-min hot-smoke treatment without moisture, followed by 1 h of hot smoking with the wet bulb set at 74°C. To finish the process, the product was cooked in hot air to an internal temperature of 63°C and was then cooked with moist heat (85°C) to a final internal temperature of 68°C. Final cooked weights were recorded, and processed SM muscles were vacuum packaged and stored in a

<table>
<thead>
<tr>
<th>Stress classification</th>
<th>pH</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>5.75 ± .10</td>
<td>5.6 ± .25</td>
</tr>
<tr>
<td>Carrier</td>
<td>6.20 ± .07</td>
<td>2.5 ± .25</td>
</tr>
<tr>
<td>Negative</td>
<td>6.46 ± .06</td>
<td>2.8 ± .25</td>
</tr>
</tbody>
</table>

*pH values taken 45 min postmortem.

1 = white, 5 = dark red.

Means with different superscripts in the same column differ (P < .05).

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4Putnam-Moore, Inc., Terre Haute, IN.
5Townsend Engineering Co., Des Moines, IA.
6S. & F. Maurer, Bronx, NY.
Table 2. Mean sensory values* for cured semimembranosus muscle slices from animals of three stress classifications

<table>
<thead>
<tr>
<th>Sensory attribute</th>
<th>Overall palatability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>Juiciness</td>
</tr>
<tr>
<td>Negative</td>
<td>5.0b</td>
</tr>
<tr>
<td>Carrier</td>
<td>5.1b</td>
</tr>
<tr>
<td>Positive</td>
<td>4.7b</td>
</tr>
<tr>
<td>SE</td>
<td>.2</td>
</tr>
</tbody>
</table>

*Scores were assigned to ratings on a seven-point facial hedonic scale, 7 was liked the most and 1 the least.

b, c Means with different superscripts in the same column differ (P < .05).

2°C cooler until sensory evaluation, proximate analysis, and color measurements were done.

Sensory Evaluation. Six samples, representing all of the treatment combinations were presented to panelists at 2:00 p.m. on seven consecutive work days. Slices (1.27 cm) were removed from the center of the SM muscle and cut into 1.27-cm cubes (AMSA Meat Cookery and Sensory Guideline Committee, 1978). Samples from control SM muscles (stress negative, control) were used for warm-up samples. Cold samples placed in coded glass bowls were served to an untrained panel consisting of approximately 30 Iowa State University faculty, staff, and students. The panelists used a seven-point facial hedonic scale to record their impressions. Numbers were assigned for statistical analysis (7 = like extremely, 1 = dislike extremely). Sensory attributes evaluated were juiciness, texture, flavor, and overall palatability. Means of the session were used for statistical analysis.

Proximate Analysis. Triplicate samples from each SM were analyzed for moisture (vacuum oven drying), fat (Soxhlet ether extract), and protein (microKjeldahl) content by using AOAC (1990) procedures in the Iowa State University Meat Laboratory.

Color Measurements. Color measurements were conducted on the processed product to determine the effect of stress classification and pST treatment on the color of product sold to the consumer. Color measurements for processed SM muscle slices were made with a Hunter Labscan7 with a cool white fluorescent light source and a 1.27-cm aperture opening. The instrument was standardized according to the manufacturers instructions using a black glass for zero and a white plate (#LS-12029) overwrapped with polyvinylchloride for 100. Measurements were made on samples overwrapped with polyvinylchloride wrap. Samples were overwrapped to prevent contamination of the instrument with meat juices. The mean of three measurements was used for statistical analysis.

Statistics. This study was a factorial experiment with a 2 x 3 arrangement. The factors were two pST treatments and three stress-genotype classifications. Data were evaluated using the SAS GLM procedure. Procedures to calculate least squares means (SAS, 1985a,b) were used to separate means. The statistical model used included pST treatment, stress classification, and source of the SM muscles (carcass identification). Sex (barrows vs gilts) was tested and had no significant effect on any of the measures so the data were pooled across sexes and analyzed as described.

Results and Discussion

Treatment of animals with pST had no significant effect on the sensory attributes of SM muscle slices nor was an interaction between the stress classification and pST observed. These observations agree with data published by Prusa et al. (1990), who reported that trained panelists found no difference in sensory attributes of SM muscles from animals treated with pST (4 mg/d). These data suggest that treatment of animals with pST does not affect the palatability of processed products.
Slices of SM muscle from stress-positive animals, however, had decreased ($P < .05$) scores for texture, flavor, and overall palatability (Table 2). This finding agrees with observations of Wismer-Pedersen (1960), who found decreased taste and texture scores for hams made from PSE muscle.

Treatment of animals with pST had no significant effect on protein and lipid composition of cured and cooked SM muscle, but a significant increase in moisture content (Table 3) was noted. Prusa and coworkers (1989), however, found no difference in fat, moisture, or protein content in fresh cooked SM muscles from pigs treated with pST. Prusa and coworkers (1990) also observed no difference in fat, moisture, or protein content between hams made from pigs treated with pST and controls.

The values reported herein are similar to those reported by Prusa et al. (1990). Semimembranosus muscles from stress-positive animals had significantly less lipid content than normal animals, but lipid content was not different in SM muscles from carrier animals (Table 4). Semimembranosus muscles from stress-positive animals were not different in moisture or protein content. Merkel (1971) also observed no difference in proximate composition between hams made from normal or PSE muscle. No interaction between pST treatment and stress classification was observed in this study for moisture, lipid, or protein contents.

Treatment of animals with pST did not significantly affect Hunter values of SM muscle slices nor was there a significant interaction between pST and stress classification. These observations were supported by those of Prusa et al. (1990), who saw no difference for color values between pST and control hams. Semimembranosus muscle slices from stress-positive animals, however, had greater ($P < .05$) Hunter a and b (Table 5) values. These values would indicate a redder and yellower color of SM muscle slices from stress positive animals in contrast to SM muscle slices from normal animals. Stress classification of animals did not significantly influence Hunter L values of SM muscle slices. This observation disagrees with the data of Merkel (1971), in which he found a lighter color in hams made from PSE muscle. A smaller a (redness) value could be expected because of a paler color of the starting material, but this was not observed in our experiment.

Cooking yields and brine uptake of SM muscles from pST-treated animals were not significantly different from placebo animals. This observation is supported by the results of Prusa et al. (1990). They saw no differences in cooking yields between hams made from

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**TABLE 3. MEAN VALUES FOR PROXIMATE COMPOSITION OF CURED SEMIMEMBRANOSUS MUSCLES FROM CONTROLS AND PIGS TREATED WITH PORCINE SOMATOTROPIN (pST)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture, %</th>
<th>Fat, %</th>
<th>Protein, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placebo</td>
<td>70.2b</td>
<td>2.5a</td>
<td>21.8a</td>
</tr>
<tr>
<td>pST</td>
<td>71.2a</td>
<td>2.0b</td>
<td>20.7a</td>
</tr>
<tr>
<td>SE</td>
<td>.3</td>
<td>.2</td>
<td>.6</td>
</tr>
</tbody>
</table>

*a,b,Means with different superscripts in the same column differ ($P < .05$).

*Standard error of least squares means.

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**TABLE 4. MEAN VALUES FOR PROXIMATE COMPOSITION OF CURED SM MUSCLES FROM ANIMALS OF THREE STRESS CLASSIFICATIONS**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Moisture, %</th>
<th>Fat, %</th>
<th>Protein, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>70.5a</td>
<td>3.0a</td>
<td>21.7a</td>
</tr>
<tr>
<td>Carrier</td>
<td>71.3a</td>
<td>2.2b</td>
<td>20.4a</td>
</tr>
<tr>
<td>Positive</td>
<td>70.4a</td>
<td>1.7b</td>
<td>21.6a</td>
</tr>
<tr>
<td>SE</td>
<td>.3</td>
<td>.3</td>
<td>.7</td>
</tr>
</tbody>
</table>

*a,b,Means with different superscripts in the same column differ ($P < .05$).

*Standard error of least squares means.
animals treated with pST and hams made from control animals. The increased protein content does not result in an apparent higher water-binding capacity. There is an increased moisture content coincident with the increased protein content, therefore, the protein already has increased water bound to it and does not bind a greater percentage of added water. Also, yields are expressed on a percentage basis of the original muscle weight. These observations could explain why an increased yield was not seen in the hams from pST-treated animals. These results suggest that pST treatment of animals had no effect on the processing characteristics of their meat. Thus, the treatment of animals with pST does not affect processing yields and will not result in economic losses. Semimembranosus muscles from stress-positive animals, however, had significantly smaller cooking yields than SM muscles from normal or carrier animals (Table 6). Merke! (1971) also showed a decrease in ham cooking yields when the starting muscle displayed the PSE condition. No significant (P < .05) difference in brine uptake between the stress classifications was observed. This agrees with observations of Severini and coworkers (1986), who saw no difference in brine uptake between normal and PSE longissimus muscle.

In summary, this is the first study to investigate and report the effects of pST and stress susceptibility on the sensory and processing characteristics of SM muscles. Sensory scores for SM muscles from pST-treated animals were no different from control animals nor was there any difference in processing characteristics. Consequently the use of pST offers promise in reducing fatness and increasing leanness. These results suggest that pST has no detrimental effect on palatability or processing characteristics of SM muscles. Those animals classified as stress-susceptible, however, had decreased sensory scores and processing yields.

**Implications**

In this study, animals of three stress classifications, positive, negative, and carrier, were treated with porcine somatotropin. No increase in pale, soft, exudative meat was observed with the use of porcine somatotropin. Therefore, these observations suggest that porcine somatotropin does not increase the incidence of pale, soft, exudative meat. Furthermore, treatment of animals with porcine somatotropin does not affect the processing or palatability characteristics of cured semimembranosus muscles from treated animals.

**Literature Cited**


and Meat Board, Chicago, IL.