

4-1995

# A Comparison of Preferences for Pork Sandwiches Produced from Animals With and Without Somatotropin Administration

John A. Fox  
*Kansas State University*

Brian L. Buhr  
*University of Minnesota*

Jason F. Shogren  
*Yale University*

James B. Kliebenstein  
*Iowa State University, jklieben@iastate.edu*

Dermot J. Hayes  
Follow this and additional works at: [http://lib.dr.iastate.edu/econ\\_las\\_pubs](http://lib.dr.iastate.edu/econ_las_pubs)  
*Iowa State University, dhayes@iastate.edu*

 Part of the [Agribusiness Commons](#), [Agricultural and Resource Economics Commons](#), [Agricultural Economics Commons](#), [Animal Sciences Commons](#), and the [Economics Commons](#)

The complete bibliographic information for this item can be found at [http://lib.dr.iastate.edu/econ\\_las\\_pubs/6](http://lib.dr.iastate.edu/econ_las_pubs/6). For information on how to cite this item, please visit <http://lib.dr.iastate.edu/howtocite.html>.

---

This Article is brought to you for free and open access by the Economics at Iowa State University Digital Repository. It has been accepted for inclusion in Economics Publications by an authorized administrator of Iowa State University Digital Repository. For more information, please contact [digirep@iastate.edu](mailto:digirep@iastate.edu).

---

# A Comparison of Preferences for Pork Sandwiches Produced from Animals With and Without Somatotropin Administration

## **Abstract**

Experimental auction markets were designed and used to investigate consumer preferences for sandwiches produced with meat from pigs treated with porcine somatotropin. A second-price, sealed-bid auction procedure was used to determine willingness to pay to exchange a pork loin sandwich with leaner meat from pigs treated with somatotropin for a similar sandwich with meat from untreated pigs. The research was conducted using a sample of 114 undergraduate students in Iowa, Arkansas, Massachusetts, and California. At the end of the experiment 33 of 58 subjects would not bid to change their leaner pork for typical pork, whereas 15 of 56 subjects would not bid to change their typical pork for leaner pork. The results suggest a preference for leaner meat from the treated pigs, but also the potential for niche markets for meat and meat products from untreated pigs.

## **Disciplines**

Agribusiness | Agricultural and Resource Economics | Agricultural Economics | Animal Sciences | Economics

## **Comments**

This article is from *Journal of Animal Science* 73, no. 4 (April 1995): 1048–1054.

# JOURNAL OF ANIMAL SCIENCE

*The Premier Journal and Leading Source of New Knowledge and Perspective in Animal Science*

## **A comparison of preferences for pork sandwiches produced from animals with and without somatotropin administration.**

J A Fox, B L Buhr, J F Shogren, J B Kliebenstein and D J Hayes

*J ANIM SCI* 1995, 73:1048-1054.

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://www.journalofanimalscience.org/content/73/4/1048>



**American Society of Animal Science**

[www.asas.org](http://www.asas.org)

# A Comparison of Preferences for Pork Sandwiches Produced from Animals With and Without Somatotropin Administration<sup>1</sup>

John A. Fox\*, Brian L. Buhr†, Jason F. Shogren‡, James B. Kliebenstein§, and Dermot J. Hayes§

\*Kansas State University, Manhattan 66506; †University of Minnesota, St. Paul 55108;

‡Yale University, New Haven, CT 06520; and §Iowa State University, Ames 50011

**ABSTRACT:** Experimental auction markets were designed and used to investigate consumer preferences for sandwiches produced with meat from pigs treated with porcine somatotropin. A second-price, sealed-bid auction procedure was used to determine willingness to pay to exchange a pork loin sandwich with leaner meat from pigs treated with somatotropin for a similar sandwich with meat from untreated pigs. The research

was conducted using a sample of 114 undergraduate students in Iowa, Arkansas, Massachusetts, and California. At the end of the experiment 33 of 58 subjects would not bid to change their leaner pork for typical pork, whereas 15 of 56 subjects would not bid to change their typical pork for leaner pork. The results suggest a preference for leaner meat from the treated pigs, but also the potential for niche markets for meat and meat products from untreated pigs.

Key Words: Somatotropin, Pork, Consumer Preferences

J. Anim. Sci. 1995. 73:1048–1054

## Introduction

Porcine somatotropin (pST) has been shown to provide leaner pork when administered to hogs. Given the recent FDA approval for the commercial use of bovine somatotropin, it seems likely that commercial pST use may also be approved.

Most of the research on these biotechnological products has focused on quantifying the effects on milk and meat production and quality. On the issue of consumer acceptability, research has been conducted on sensory evaluation (Prusa et al., 1993). However, an important issue is whether inexperienced consumers will purchase the new leaner pork knowing only that it is leaner and comes from pigs administered somatotropin. The results of two surveys in this area have been inconclusive (Pitman-Moore, 1986; Hoban and Burkhardt, 1991). In a new approach, Buhr et al. (1993), using an experimental method, (Shin et al., 1992; Shogren et al., 1994) found that students at a midwestern university placed greater value on the attribute of leanness of pork from pigs administered pST than on any concerns they may have had with the use of somatotropin.

This paper applies the experimental approach to examine regional preferences for pork from pigs treated with somatotropin. We focus on the decision facing the inexperienced consumer when first faced with a choice between pork from treated and untreated pigs. The use of recombinant pST may result in some ambiguity for consumers; they must balance their preferences toward the leaner pork product with potential concerns arising from the use of the biotechnological product. Given this ambiguity, we believe that the non-hypothetical experimental method provides a more accurate and reliable estimate of economic value than traditional survey techniques.

We conducted this research using eight groups of undergraduate students in four different locations in the United States: Iowa, Arkansas, Massachusetts, and California. Although some studies have found differences in taste and palatability (Prusa et al., 1993) between these products, we ignored these findings in order to focus on differences in production and fat content. We should point out that sensory evaluation plays no role in the valuation procedure that follows; products were consumed only at the conclusion of the experiments.

## Experimental Procedures

Laboratory experimental auctions (Coursey, 1987; Cox et al., 1982; Shogren, 1993; Fox et al., 1994) have

<sup>1</sup>Journal Paper No. J-15542 of the Iowa Agric. and Home Economics Exp. Sta., Ames. Project no. 2994.

Received May 27, 1993.

Accepted November 21, 1994.

specific advantages over traditional consumer survey techniques:

1. Non hypothetical: In these auctions participants realize the actual monetary consequences of their bidding, thereby providing more incentive for them to reveal their true value for the good in question.
2. Repeated market experience: Each auction consists of several rounds of bidding, thereby allowing participants to update their bids to reflect market prices or new information.
3. "Requirement-to-eat" factor: Participants were paid \$18 to participate, and were informed that a product would have to be consumed at the end of the experiment in order for them to leave with their take-home income. This proviso led to the withdrawal of vegetarian subjects in some experiments.
4. Absence of non-response bias: Non-response bias is a common problem with survey techniques (Cummins et al., 1986). In our experiments, participants were not given any indication as to the nature of the study at the time they were recruited. Willingness to participate is therefore independent of a subject's attitude to the product.

These experiments used a second-price, sealed-bid auction mechanism in which the highest bidder receives the product being auctioned, but pays an amount equal to the second-highest bid. This type of auction mechanism has been shown to induce each participant to submit a bid equal to his or her actual valuation of the item being auctioned, independent of other bidders' behavior (Vickrey, 1961). The fact that the winning bidder does not have to pay the amount that he/she bids removes the incentive to underbid one's true value that is present in a first-price auction. In a second-price auction there is no benefit from either overbidding or underbidding one's true valuation of the item being auctioned. Repeated trials of this auction mechanism are used to allow for learning (see Menkhaus et al., 1992 for a review of auction methods).

Each experiment consisted of two stages. Stage 1 familiarized the participants with the Vickrey second-price, sealed-bid auction by using a common market good, a candy bar. Our objective was to eliminate any confusion about the auction procedures before we introduced the meat products in Stage 2. In Stage 1, each participant was given an identification number (ID), a \$3 endowment, and a regular-sized, brand-name candy bar (brand X). The auction worked as follows: a different regular-sized, brand-name candy bar (brand Y) was displayed, and each participant submitted a sealed bid indicating the maximum he or she would be willing to pay to exchange brand X for brand Y. After all bids were collected, the monitor displayed on the blackboard the ID number of the

winner of that round of bidding (trial), that is, the ID of the highest bidder, and the market price, that is, the second-highest bid. Five auction trials were conducted. Note that to control for wealth effects (changes in bids caused by winning an earlier trial), participants were fully aware that only one of the five trials would be binding (see Davis and Holt [1993] for a discussion of wealth effects in experimental markets). The binding trial was randomly selected after all five trials were complete. The highest bidder in the binding trial exchanged his or her brand X candy bar for brand Y and paid the market price (i.e., the second-highest bid in the binding trial). The cash transaction reminded all participants that their bidding had real monetary consequences.

Stage 2 introduced the pork sandwiches. Each participant was given a \$15 endowment and informed that they also possessed a Type I (leaner) pork loin sandwich with meat from a pig treated with porcine somatotropin. They were also informed that a Type II (typical) pork loin sandwich would be auctioned using the Vickrey procedure over 20 trials. Representative sandwiches, identically wrapped in white paper, were shown to the subjects. They were informed that their sandwiches would be prepared, both types in identical fashion, in adjoining kitchen facilities while the auction progressed. The monitor provided each participant with the following description of the two sandwiches for the first 10 trials: (Type I) This meat is 10 to 20% leaner and contains 30 to 60% fewer calories than Type II meat. It was produced by pigs treated with a growth enhancer. (Type II) This meat is typical of meat currently available at restaurants and grocery stores. For the first 10 trials, each participant submitted "naive" bids that reflected his or her maximum willingness to pay to exchange the Type I sandwich for the Type II sandwich based only on these descriptions. Because we did not show meat samples to participants we eliminated bidding due to perceived differences in color, marbling, size, etc. Our objective was to focus only on differences in production technology and leanness.

After the 10th trial, the monitor provided the following additional information about the growth enhancer:

The growth enhancer administered to the pigs is known as a somatotropin. It has the effect of not only increasing daily gain and improving feed efficiency, but also increases the amount of lean meat produced and reduces the amount of fat produced. This is referred to as a partitioning effect of nutrients. Scientists assure us that other than the lean/fat changes the composition of meat produced by treated pigs is unchanged. Further studies have shown that there is no change in the taste, tenderness or other palatability characteristics of the meat.

Following provision of the additional information, 10 "informed" bids were elicited. These were trials 11 through 20. Again, to control for wealth effects, one of the 20 trials was randomly selected to be binding. The highest bidder in the binding trial received the Type II sandwich and paid the second-highest bid in the binding trial. Everyone else kept the Type I sandwich. Note that all participants were required to eat their sandwiches at the end of the experiment in order to leave with their income.

To provide a complete evaluation of preferences with respect to pST we also conducted a set of four experiments at the same locations in which we reversed the endowments of sandwiches. We will refer to these four experiments as constituting Treatment B. In Treatment B, participants were each provided with a Type II (typical) sandwich and were asked to bid for a Type I (leaner) sandwich. Note that subjects were only allowed to participate in one experimental auction (a complete set of experimental instructions is available from the authors on request).

A total of eight experiments were carried out at four universities in Iowa, Arkansas, Massachusetts, and California (one Treatment A and one Treatment B at each) between April and August of 1992. Fifteen undergraduate students from a range of degree programs participated in each experiment. Undergraduates were chosen chiefly for ease of recruiting (by poster) and because other experimental studies (Bennett, 1987; DeJong et al., 1988; Dyer et al., 1989) have revealed similar behavior between student and adult groups. Care was taken to replicate the experiment as closely as possible in a similar environment at all four locations. The basic requirements were a room to comfortably seat about 20 people, a blackboard, and adjoining kitchen facilities. Although facilities varied somewhat between locations, these basic requirements were met. All experiments were conducted by the same investigator.

## Results and Discussion

In our discussion of the results we will first consider Treatment A, the four experiments in which participants bid to exchange a Type I (leaner) sandwich

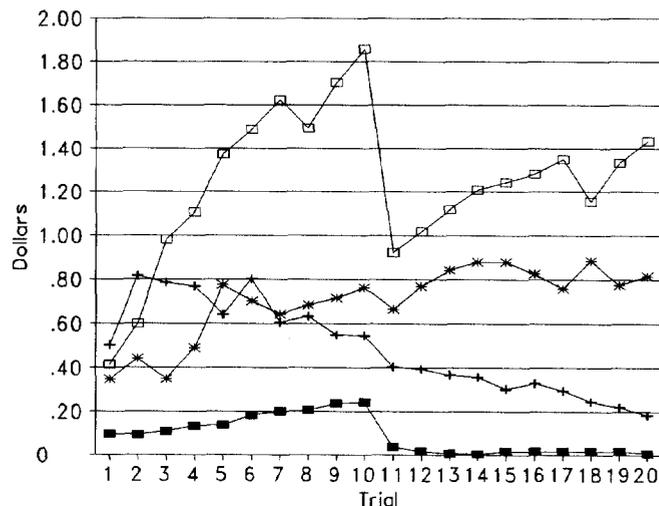


Figure 1. Mean bid to exchange a Type I sandwich (with leaner meat from a pig treated with porcine somatotropin) for a Type II sandwich (with meat from an untreated pig). Iowa (■), Arkansas (+), Massachusetts (\*), and California (□).

for a Type II (typical) sandwich. We begin by discussing the overall pattern of bidding and then deal in turn with the bids in the first trial, the "naive" bids over the first 10 trials, the effect on bids of providing information about somatotropin, and then the "informed" bids over Trials 11 through 20. Finally we discuss the results of the Treatment B in which participants bid for the Type I (leaner) sandwich.

### Treatment A

Figure 1 shows the mean bid of each trial at all four locations. On average, participants in California would pay the most to avoid the leaner meat, both before and after being informed that the growth enhancer was somatotropin. The mean bid over all 20 trials was \$1.23 in California, \$.70 in Massachusetts, \$.49 in Arkansas, and \$.09 in Iowa. Because negative bids were not allowed we can assume that a zero bid indicates indifference between the two types of pork, or perhaps a preference for the Type 1 (leaner) pork.

Table 1. Number of participants bidding zero to exchange a Type I (leaner) pork sandwich for a Type II (typical) sandwich

| Trial          | Location |          |               |            |
|----------------|----------|----------|---------------|------------|
|                | Iowa     | Arkansas | Massachusetts | California |
| 1              | 10       | 7        | 7             | 3          |
| 10             | 9        | 6        | 7             | 2          |
| 11             | 13       | 7        | 7             | 5          |
| 20             | 13       | 8        | 7             | 5          |
| Total in group | 15       | 15       | 15            | 13         |

Table 2. Comparison of mean bids to exchange a Type I (leaner) pork sandwich for a Type II (typical) pork sandwich

| Location <sup>a</sup> | Trial <sup>b</sup>             |                                 |                                |                                 |
|-----------------------|--------------------------------|---------------------------------|--------------------------------|---------------------------------|
|                       | 1                              | 10                              | 11                             | 20                              |
| Iowa                  | \$.09 <sup>c</sup><br>(\$0)    | \$.24 <sup>c</sup><br>(\$0)     | \$.04 <sup>c</sup><br>(\$0)    | \$0 <sup>c</sup><br>(\$0)       |
| Arkansas              | \$.50 <sup>d</sup><br>(\$ .25) | \$.55 <sup>cd</sup><br>(\$ .50) | \$.40 <sup>d</sup><br>(\$ .15) | \$.18 <sup>d</sup><br>(\$0)     |
| Massachusetts         | \$.35 <sup>d</sup><br>(\$ .30) | \$.76 <sup>d</sup><br>(\$ .40)  | \$.67 <sup>d</sup><br>(\$ .20) | \$.82 <sup>e</sup><br>(\$ .55)  |
| California            | \$.41 <sup>d</sup><br>(\$ .50) | \$1.86 <sup>e</sup><br>(\$1.00) | \$.92 <sup>d</sup><br>(\$ .50) | \$1.43 <sup>e</sup><br>(\$2.00) |

<sup>a</sup>n = 15 for each group except California, where n = 13.

<sup>b</sup>Numbers in parentheses are median bids.

<sup>c,d,e</sup>Mean bids in a column not followed by the same letter in their superscript are different at  $P < .05$  using standard  $t$ -tests for differences in means (Freund and Walpole, 1987).

Table 1 shows the number of zero bids submitted in different trials at each location. It is clear that the Type I (leaner) meat was most acceptable to the Iowa group; between 9 and 13 of those 15 participants bid zero at different stages in the auction. The preference for the leaner meat was lowest in California; a maximum of 5 participants out of 13 bid zero at any stage.

The first trial of bidding in each experiment reflects the respondents' initial preferences given the descriptions of Type I and Type II pork. In Trial 1, the mean bid in Iowa at \$.09 (with 10 zero bids) was significantly lower than at any of the other locations (Table 2). The highest mean bid in the first round occurred in Arkansas at \$.50, followed by California at \$.41, and Massachusetts at \$.35.

Through Trials 1 to 10, participants bid on the basis of their prior knowledge or subjective perceptions of growth enhancers, their preferences regarding fat content, and the revealed market price. At each location the average bid at Trial 10 exceeded that of Trial 1. In California, the average bid increased from \$.41 to \$1.86, suggesting that a number of participants were progressively increasing their bids to avoid the Type I meat. The difference in the pattern of bidding between Trials 1 and 10 demonstrates the value of repeated market participation in eliciting the

willingness to pay measure. Had we used Trial 1 as our value measure we would have concluded that willingness to pay for the Type II sandwich was similar in Arkansas, California, and Massachusetts but significantly lower in Iowa. However, after 10 trials a different pattern emerged, with willingness to pay in California exceeding that of any other location. This demonstrates a key advantage of this experimental method over traditional surveys.

Following our description of the growth enhancer as a somatotropin, the average bid in all four experiments decreased. Table 1 shows the corresponding increase in the number of zero bids at three of the four locations, and Table 2 shows the decrease in median bid at each location except Iowa, where the median was already zero. A Wilcoxon signed-rank test indicated that the decrease in bidding was significant ( $P < .05$ ) for Iowa and California. Thus there was no adverse reaction to the identification of the growth enhancer as a somatotropin.

Following Trial 11, the "informed" bids in both California and Massachusetts resumed an upward trend reflecting lingering reservations by some participants about the leaner product. The average bids in California increased steadily until Trial 18 and finished at \$1.43 in Trial 20. This upward trend was driven by two participants whose individual bids

Table 3. Number of participants bidding zero to exchange a Type II (typical) pork sandwich for a Type I (leaner) sandwich

| Trial          | Location |          |               |            |
|----------------|----------|----------|---------------|------------|
|                | Iowa     | Arkansas | Massachusetts | California |
| 1              | 3        | 6        | 4             | 5          |
| 10             | 2        | 5        | 3             | 5          |
| 11             | 1        | 6        | 3             | 1          |
| 20             | 2        | 6        | 5             | 2          |
| Total in group | 14       | 14       | 14            | 14         |

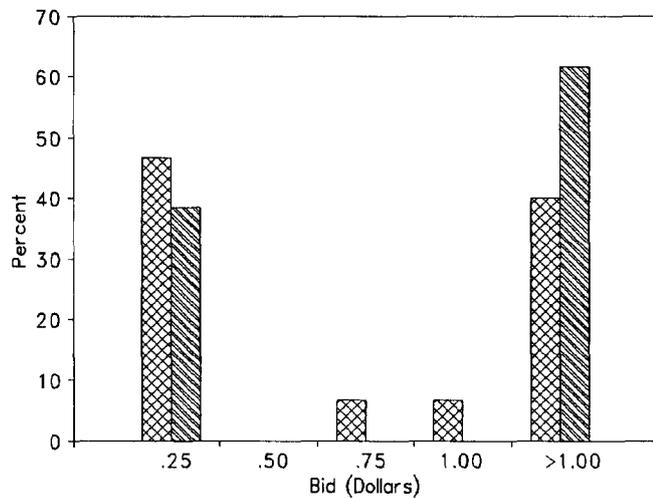
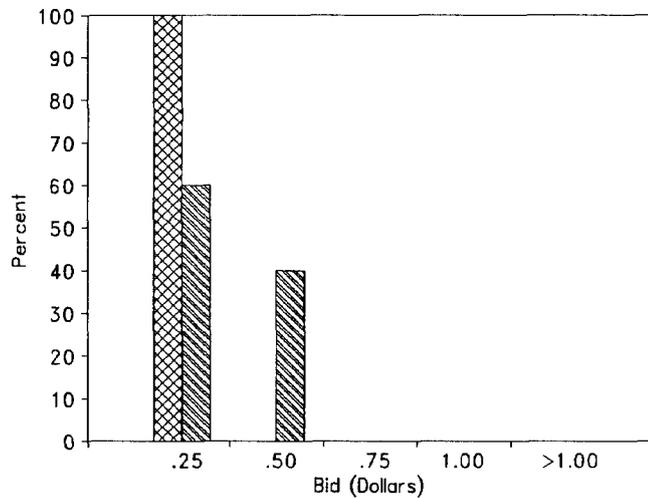


Figure 2. Trial 20. Bids to exchange a Type I (leaner) pork sandwich for a Type II (typical) pork sandwich. Top graph: Iowa (crosshatch), Arkansas (diagonal); bottom graph: Massachusetts (crosshatch), California (diagonal).

reached in excess of \$3.00. In Massachusetts, the average bid increased until Trial 15, and ended up in the \$.75 to \$.90 range. In Massachusetts, three or four participants were involved in the "bidding war," with some bids in excess of \$2.00.

In Arkansas and Iowa, following the drop in bids at Trial 11, bids continued to decrease until the end of the experiment. Information provided after Trial 10 had apparently reassured these participants of the safety of the product and there was no "bidding war" to obtain the typical pork product. In Iowa the mean

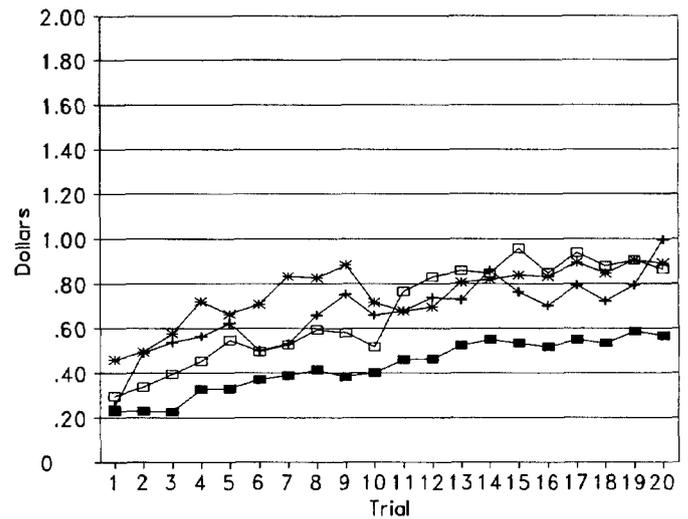


Figure 3. Mean bid to upgrade from a Type II sandwich (with meat from an untreated pig) to a Type I sandwich (with leaner meat from a pig treated with porcine somatotropin). Iowa (■), Arkansas (+), Massachusetts (\*), and California (□).

bid fell to zero, whereas in Arkansas it fell below \$.20.

Figure 2 shows the frequency distribution for the bids at Trial 20, the final round of bidding. In Iowa all bids were at or close to zero. If the bids had not been truncated at zero it is possible that the leaner pork would have commanded a premium over the "typical" pork among these participants. In Arkansas at Trial 20 all the bids were at or below \$.50, with 8 of the 15 being at zero. In California and Massachusetts, bids had a bimodal distribution with slightly less than half of the participants bidding zero. The other participants, however, were willing to pay \$1.00 or more (in some instances more than \$2.00) to avoid the somatotropin-produced product. These bids raise the possibility of a "niche" market for pork products from untreated pigs if the commercial use of these hormones becomes prevalent (Buhr et al., 1993).

### Treatment B

Participants in Treatment A could only indicate their preference for the Type I (leaner) pork with a zero bid. It is likely that many of those bidding zero would be willing to pay a premium for the leaner product. To avoid the difficulties associated with negative bidding, we conducted another series of experiments to investigate the extent of preference for the leaner pork.

Figure 3 shows the mean bid of each trial in the experiments in which participants were given a Type II (typical) sandwich and asked to bid for a Type I (leaner) sandwich. The contrast with Figure 1 is apparent. In Treatment B, the average bid follows a similar pattern in each location. The average bid in all

four experiments increased between Trials 1 and 10 and again between Trials 11 and 20.

Figure 3 suggests that participants in Iowa had a lower level of preference for leaner pork, but according to Table 3, the leaner pork was most preferred in Iowa, with fewest zero bids. At Trial 1 the average bid in Massachusetts was slightly higher than that in the other locations, but this difference was not significant (Table 4).

Bids increased at each location between Trials 1 and 10. Following information on somatotropin, the average bid increased in three locations. The Wilcoxon test indicated that the increase was significant ( $P < .05$ ) in Iowa and California. After Trial 11, the average bids continued an upward trend at each location.

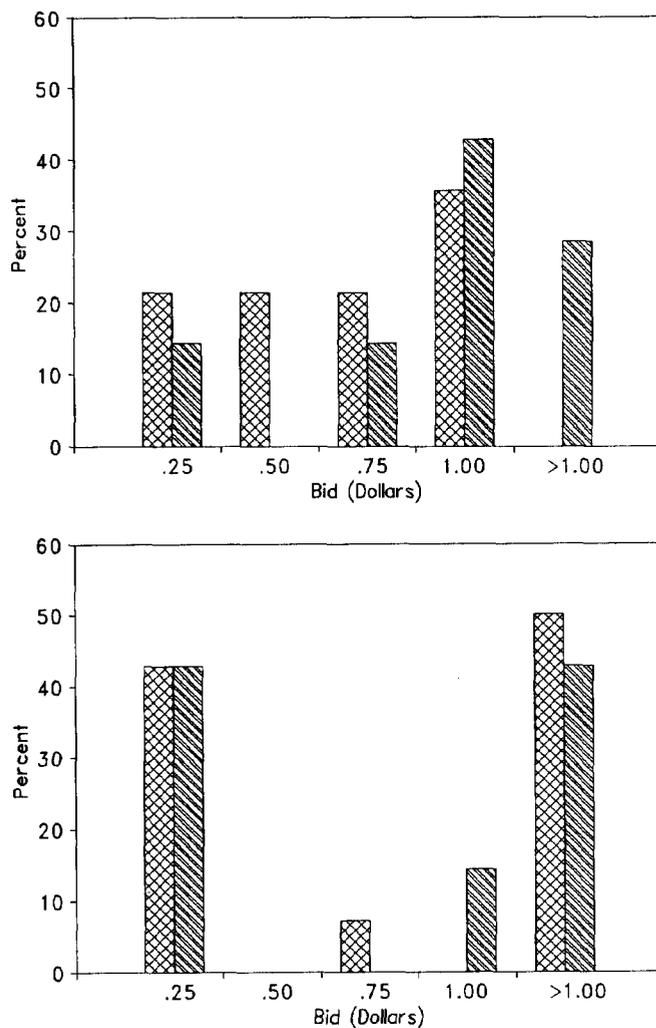


Figure 4. Trial 20. Bids to exchange a Type II (typical) pork sandwich for a Type I (leaner) pork sandwich. Top graph: Iowa (crosshatch), California (diagonal); bottom graph: Arkansas (crosshatch), Massachusetts (diagonal).

Figure 4 shows the distribution of bids at Trial 20. For Iowa and California the bids are uniformly distributed, but for Arkansas and Massachusetts the distributions are bimodal with seven and eight zero bids, respectively.

### Summary

The results can be summarized as follows. In Iowa, the leaner meat from pST-treated pigs was acceptable to almost all participants. At Trial 20 in Iowa, only 2 of 15 participants bid to avoid lean pork, whereas 12 of 14 participants in another group bid to receive it. In Arkansas, California, and Massachusetts about half the participants ended Treatment A with bids to avoid lean pork. Bids in California and Massachusetts were substantially larger than those in Arkansas. In Treatment B, a majority of participants at these three locations bid to obtain the leaner pork. The results suggest the potential for a niche market for meat and meat products from untreated pigs in the event of pST being approved.

The overall bidding patterns suggest a greater preference for leaner pork produced from pigs administered porcine somatotropin. In Treatment B, 50 of 56 participants (89%) indicated a preference for leaner pork by submitting a positive bid to exchange Type II (typical) pork for Type I (leaner) pork. In Treatment A, participants could bid to exchange Type I (leaner) pork for Type II (typical) pork. Given a description of the growth enhancer and informed that it was somatotropin, 28 of 58 participants (48%) did not submit any positive bid for typical pork.

### Implications

These experiments explored the decision that retail customers will confront when they first encounter pork products from animals treated with porcine somatotropin. We used real money and real meat products in a nonhypothetical laboratory setting with repeated market experience and replicated the experiments in Arkansas, California, Iowa, and Massachusetts. We introduced new information halfway through the experiment that informed participants that what had been described to them as a growth enhancer was somatotropin. The new information provided an accurate description of how pST works and informed participants that the scientific community considered the product to be safe. This information caused bids for leaner pork to increase and bids to avoid leaner pork to decrease. We conclude that consumers are no more averse to somatotropin than to products described under the general label of growth enhancers.

Table 4. Comparison of mean bids to exchange a Type II (typical) pork sandwich for a Type I (leaner) pork sandwich

| Location <sup>a</sup> | Trial <sup>b</sup> |                    |                                  |                                   |
|-----------------------|--------------------|--------------------|----------------------------------|-----------------------------------|
|                       | 1                  | 10                 | 11                               | 20                                |
| Iowa                  | \$ .23<br>(\$ .25) | \$ .40<br>(\$ .37) | \$ .46 <sup>c</sup><br>(\$ .50)  | \$ .57 <sup>c</sup><br>(\$ .67)   |
| Arkansas              | \$ .25<br>(\$ .07) | \$ .66<br>(\$ .50) | \$ .68 <sup>cd</sup><br>(\$ .58) | \$ 1.00 <sup>cd</sup><br>(\$ .95) |
| Massachusetts         | \$ .46<br>(\$ .15) | \$ .72<br>(\$ .85) | \$ .68 <sup>cd</sup><br>(\$ .60) | \$ .89 <sup>cd</sup><br>(\$ 1.00) |
| California            | \$ .30<br>(\$ .15) | \$ .52<br>(\$ .60) | \$ .77 <sup>d</sup><br>(\$ .92)  | \$ .87 <sup>d</sup><br>(\$ 1.00)  |

<sup>a</sup>n = 14 for each group.

<sup>b</sup>Numbers in parentheses are median bids.

<sup>c,d</sup>Mean bids in a column not followed by the same letter in their superscript are different at  $P < .05$  using standard  $t$ -tests for differences in means (Freund and Walpole, 1987).

### Literature Cited

- Bennett, J. 1987. Strategic Behavior. *J. Public Econ.* 32:355.
- Buhr, B. L., D. J. Hayes, J. F. Shogren, and J. B. Kliebenstein. 1993. Valuing ambiguity: The case of genetically engineered growth enhancers. *J. Agric. Resource Econ.* 18:175.
- Coursey, D. L. 1987. Markets and the measurement of value. *Public Choice* 55:291.
- Cox, J. L., B. Roberson, and V. L. Smith. 1982. Theory and behavior of single object auctions. In: V. L. Smith (Ed.) *Research in Experimental Economics*. Vol. 2, 1. J.A.I. Press, Greenwich, CT.
- Cummings, R. G., D. S. Brookshire, and W. D. Schulze. 1986. *Valuing Environmental Goods: An Assessment of the Contingent Valuation Method*. Rowman & Allanheld, Totowa, NJ.
- Davis, D. D., and C. A. Holt. 1993. *Experimental Economics*. Princeton University Press, Princeton, NJ.
- DeJong, D. V., R. Forsythe, and W. C. Uecker. 1988. A note on the use of businessmen as subjects in sealed offer markets. *J. Econ. Behav. Organiz.* 9:87.
- Dyer, D., J. H. Kagel, and D. Levin. 1989. A comparison of naive and experienced bidders in common value offer auctions: A laboratory analysis. *Econ. J.* 99:108.
- Fox, J. A., D. J. Hayes, J. B. Kliebenstein, and J. F. Shogren. 1994. Consumer acceptability of milk from cows treated with bovine somatotropin. *J. Dairy Sci.* 77:703.
- Freund, J. E., and R. E. Walpole. 1987. *Mathematical Statistics* (4th Ed.). Prentice-Hall, Englewood Cliffs, NJ.
- Hoban, T. J., and J. Burkhardt. 1991. Determinants of public acceptance in meat and milk production: North America. In: P. van der Wal, G. M. Weber, and F. J. van der Wilt (Ed.) *Biotechnology for Control of Growth and Product Quality in Meat Production: Implications and Acceptability*. Pudoc, Wageningen, The Netherlands.
- Menkhaus, D. J., G. W. Borden, G. D. Whipple, E. Hoffman, and R. A. Field. 1992. An empirical application of laboratory experimental auctions in marketing research. *J. Agric. Resource Econ.* 17:44.
- Pitman-Moore. 1986. *Pork Consumer Attitude Study: A Market Analysis*. Pitman-Moore, International Minerals and Chemicals, Terre Haute, IN.
- Prusa, K. J., C. A. Fedler, and L. F. Miller. 1993. National in-home consumer evaluations of pork roasts from pigs administered porcine somatotropin (pST). *J. Food Sci.* 58:480.
- Shin, S. Y., J. Kliebenstein, D. J. Hayes, and J. F. Shogren. 1992. Consumer willingness to pay for safer food products. *J. Food Saf.* 13:51.
- Shogren, J. F. 1993. Experimental Markets and Environmental Policy. *Agric. Resource Econ. Rev.* 22:117.
- Shogren, J. F., S. Y. Shin, D. J. Hayes, and J. Kliebenstein. 1994. Resolving differences in willingness to pay and willingness to accept. *Amer. Econ. Rev.* 84:255.
- Vickrey, W. 1961. Counterspeculation, auctions and competitive sealed tenders. *J. Finance* 16:8.

**Citations**

This article has been cited by 3 HighWire-hosted articles:  
<http://www.journalofanimalscience.org/content/73/4/1048#otherarticles>