Biotechnology Information Series

Porcine Somatotropin (pST)

Note: Porcine growth hormone (porcine somatotropin) is not approved by the Food and Drug Administration for commercial use in food animals at this time. In order for a new animal drug to be approved for marketing in the U.S., the sponsor must establish that it is effective and safe. To do this, the sponsor must establish an Investigational New Animal Drug Application. This publication is designed to explain the science of how porcine somatotropin is used, not to give the perception of pre-approval endorsement by the United States Department of Agriculture (USDA) or by the publishing state.

What is porcine somatotropin (pST)?

Porcine somatotropin, abbreviated as pST, is a growth hormone naturally produced in pigs. The word "porcine" refers to pigs, and the word "somatotropin" means body growth and refers to the name of the hormone.

Hormones are natural substances secreted by glands within the body that affect the way the body operates. Somatotropins, including pST, are protein hormones consisting of large complex peptides that contain 190 to 199 amino acids. Somatotropins are produced in the pituitary gland located at the base of the animal's brain and are released under the control of the central nervous system.

How did scientists develop pST?

In the 1930s, scientists discovered that the growth rate of animals increased when they were injected with pituitary gland extracts. When the extracts were purified, the growth hormone called somatotropin was identified.

Until recently, the only source of pST was from the pituitary glands of slaughtered pigs. There were only small quantities of pST available, and it was very expensive.

Now, the new science of biotechnology makes it possible to work with DNA, the part of a cell that contains the genetic information for an animal or a plant. Scientists have determined which gene in pigs controls or "codes for" the production of pST. They have

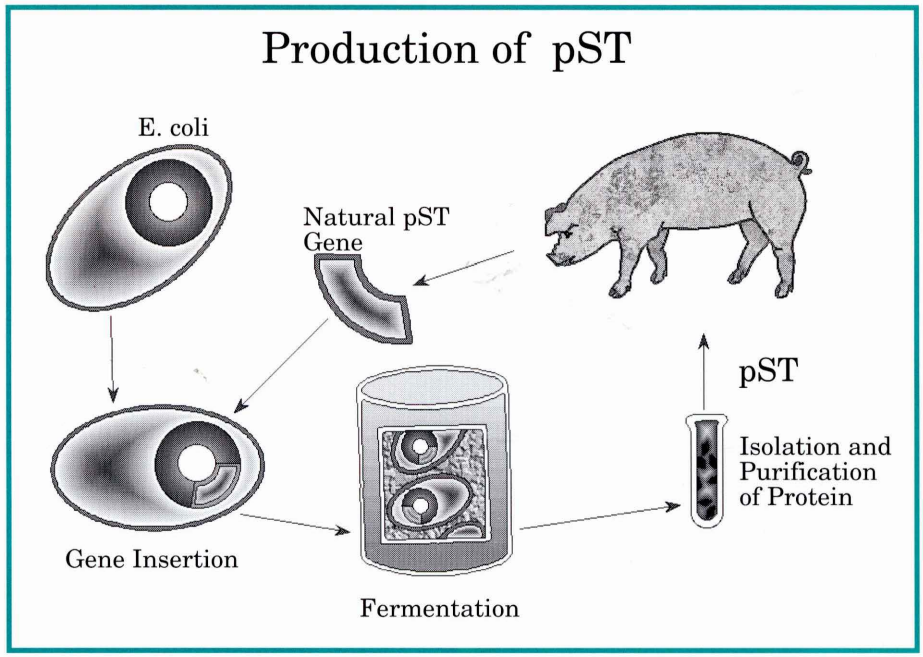

Figure 1. pST production

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isolated this gene from the pig and inserted it into a bacteria called *Escherichia coli*.

These bacteria, which are normally found in the intestinal tract of humans and animals, act like tiny factories and produce large amounts of pST in controlled laboratory conditions. The pST produced by the bacteria is purified and then injected into pigs. (See figure 1.)

The movement of a gene from one organism to another, in this case from the pituitary gland of a pig to a bacterial organism, is called "recombinant DNA technology." This technology allows the development and large-scale production of many biological products that are nearly identical in action to compounds produced by plants and animals.

Several drugs, including insulin for the treatment of diabetes and tissue plasminogen activator for the treatment of heart attacks in people, are produced in a similar way.

Table 1. Percent change from controls (Zimmerman)

	average % change	No. of Experiments
Daily gain	**+15.2**	**19**
Feed/gain	**-21.1**	**20**
Backfat	**-24.8**	**16**
Loin eye	**+18.5**	**10**
Muscle	**+ 9.9**	**7**

How does the protein nature of pST affect its use?

The fact that pST is a protein is both an advantage and a disadvantage. The advantage is that many scientists believe that pork consumers need not be concerned about eating products produced with pST technology since pST is a protein that becomes inactive when it is digested.

The disadvantage is that, because it is made inactive when it is digested, pST is not active when fed to pigs. To be effective, pST must be routinely injected into each pig during the last six weeks of growth, according to current research experience. This may considerably increase the pork producer's work. Researchers are looking at the possibility of using implants that could be placed in pigs to release pST slowly over time.

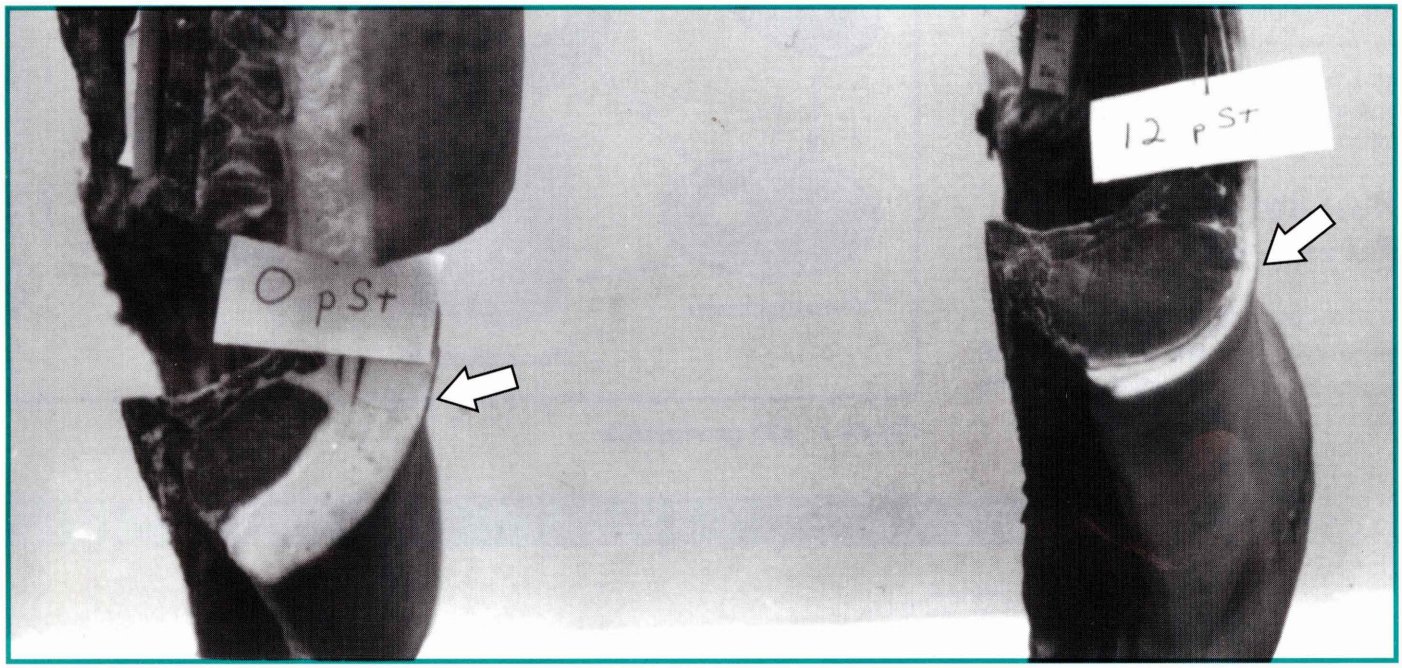

Figure 2. The carcass on the left is from a control pig that was not treated with pST, and the carcass on the right is from a pST-treated pig. The white areas are backfat.

What does the research show?

Young growing pigs produce muscle (lean) and not much fat until they reach 100 pounds or more. Then they begin to produce less muscle and increasing amounts of fat. It is at this stage that pST has its maximum potential, so most research studies use pigs that weigh at least 120 pounds.

How pST affects performance

Many studies since 1950 have demonstrated marked growth improvement in pigs treated with pST. A summary of 20 research reports from 1986 to 1989 is presented in table 1.

For pST-treated pigs, the weight gained each day (daily gain) increased and the amount of feed consumed per unit of weight gain (feed/gain) decreased. Carcass measurements showed less back-fat, a larger loin eye, and more muscle. The difference in carcass backfat is clearly visible in figure 2.

An important factor to remember is that pigs treated with pST grew on the average of 15.2 percent faster while consuming 21.1 percent less feed, producing less backfat and more muscle. This means that pST-treated pigs will need more protein and amino acids in their diets to support the increased growth.

Table 2. Comparison of high lean and average lean pigs receiving 45 ug pST/day (Campbell and Taverner)

	High lean		Average lean	
	Control	pST	Control	pST
Daily gain, lb.	**2.28**	**3.05**	**1.72**	**2.62**
Feed/gain	**3.06**	**2.00**	**3.52**	**2.15**
Backfat, in.	**1.16**	**0.82**	**1.31**	**0.96**

How a pig's body type and sex affect its response to pST

Scientists have conducted research to determine whether pST produces different responses in genetically lean or fat pigs and if castrated male pigs (barrows) respond to pST differently than males (boars) or young females (gilts).

Researchers injected a high lean group and an average lean group of pigs with 45 micrograms of pST per pig each day. In both the high lean and the average lean pigs, pST increased the daily gain, decreased the amount of feed needed to produce the gain, and decreased the carcass backfat. These results indicated that both high lean and average lean pigs benefit from pST. (See table 2.)

To study the effect of sex on response to pST, boars, gilts, and barrows were injected with the hormone.

For each of the three sex groups, pigs injected with pST consumed less feed each day, increased their daily weight gain, and had greater feed efficiency than pigs that were not treated with pST. The results indicate that pST will improve gain and feed efficiency of both male and female pigs. (See table 3.)

In 1990, Iowa State University conducted a pST field trial on 15 central Iowa farms. Producers fed two groups of finishing pigs until they reached 240 lb or 280 lb with or without pST injections of 3 or 4 milligrams per day (Prusa et al.). Pigs treated with pST had 17 percent greater feed efficiency, grew 8 percent faster, were leaner, and had increased muscle. Trimmable fat was reduced 29 percent for pST-treated pigs at 240 lb and 20 percent for pST-treated pigs at 280 lb. Pork producers viewed the project favorably and were willing to repeat it.

Table 3. Effects of sex and pST administration, 45 ug/day (Steele, et al.)

	Boars		Gilts		Barrows	
	Control	pST	Control	pST	Control	pST
Daily feed, lb.	**7.08**	**6.38**	**7.44**	**6.01**	**8.07**	**6.25**
Daily gain, lb.	**2.61**	**2.95**	**2.22**	**2.72**	**2.33**	**2.75**
Feed/gain	**2.72**	**2.21**	**3.34**	**2.21**	**3.46**	**2.33**

The effect of pST on reproduction and lactation

Gilts treated with pST may be selected for breeding. Research indicates no positive or negative carryover effects of treating gilts with pST (Day et al.).

Although bovine somatotropin (bST) improves milk production in dairy cattle, the results of treating sows with pST are not as clear. Sows treated with pST eat less feed, lose more backfat, and may increase milk production. However, there has not been any improvement in the weight gain of nursing pigs. Treating sows with pST during the summer may increase heat stress and result in more deaths (Crenshaw et al., Cromwell et al.).

Is pST safe and will consumers accept it?

A major concern for the pork industry is whether consumers will buy meat from pST-treated pigs. Even though pST causes pigs to produce leaner meat, consumers may question its safety.

The growth hormone pST is a normal component of a pig's body, just as human somatotropin or growth hormone is a part of our bodies.

Research evidence shows that somatotropins are very specific—porcine somatotropin is active only in pigs and not in humans, cattle, etc. Since it is a protein, pST is digested and made inactive when it is eaten. Cooking also destroys pST's ability to function biologically.

Iowa State University has conducted several consumer evaluations of pST-treated pork (Fedler, et al., Prusa and Fedler). Visitors to the 1989 and 1990 Iowa Pork Congresses who participated in a taste test indicated a significant preference for meat from pST-treated pigs. In 1989, 62 percent preferred summer sausage from pST-treated pigs. In 1990, 54 to 60 percent preferred the tenderness, juiciness, and flavor of loin chops from pigs treated with pST.

Also in 1990, pork loin roasts from pigs treated and not treated with pST were distributed to 108 families in Des Moines, Iowa (Fedler, et al.). The families said that the pST roasts were larger and leaner and noted no differences in "degree of liking," including juiciness or flavor. However, the families preferred the tenderness of the roasts from untreated pigs.

What are the financial considerations of pST for the pork producer?

The financial advantages and disadvantages of using pST are not yet known. The cost of pST and the cost of injecting it into pigs are undetermined. The pork producer who uses pST must feed pigs a more expensive diet that is higher in protein, but the improved gain and feed efficiency may result in greater profits.

Early adopters of pST technology may receive a premium price for pigs with less fat and more muscle. However, as pST is adopted by a larger share of producers, the premium may decrease as leanness will be expected from all pigs.

What does the FDA approval process involve?

The Food and Drug Administration (FDA), is an agency of the U.S. government that must approve pST before it can be used in commercial pork production. The FDA is required to determine the safety and effectiveness of animal drugs.

Safety covers three main areas: safety of the food products to humans, safety to the target animal (the pig), and safety to the environment. The effect of all veterinary drugs on food consumed by people is a principal concern of the FDA. Before allowing drugs for food-producing animals to be marketed, the FDA requires that these drugs be shown to be safe by rigorous scientific studies. Safety in this context means, among other things, that residues of the drug in meat, milk, or eggs are safe for people to eat.

Effectiveness means that the drug does what the company, sometimes referred to as the sponsor, claims (for example, speeds growth). In addition, companies must prove to the FDA that they can consistently manufacture the drug to a specific potency and purity.

A drug company must establish an Investigational New Animal Drug Application in order to work toward the approval of a new veterinary drug. Early in the investigational stages of all new animal drugs for food-producing animals, drug sponsors may request an authorization from the FDA to allow consumption of food products (such as meat, milk, and eggs) from treated animals during research investigating the effectiveness and animal safety of the drug. They must provide adequate and appropriate data to demonstrate that consumption of these food products will not be a health risk to humans.

What is pST's future?

Opponents of pST

Some groups have suggested banning the use of pST and other new biotechnology products based on economic factors and/or concerns about the safety of new technologies. Other groups believe that these technological advances or discoveries will have an adverse effect on small farms that do not or cannot efficiently adopt or adapt to the changes.

Proponents of pST

Supporters of pST suggest that consumers prefer meat that is low in calories, lean, nutritious, convenient, and tasty. Pork producers and processors have been improving these qualities, and proponents believe that pST allows improvements in the lean and nutritious qualities of pork.

References Cited

Campbell and Taverner, (Adapted from). *Journal of Animal Science* 66 (Suppl. 1):257 (Abstr.) 1988.

Crenshaw, et al. *Journal of Animal Science* 67 (Suppl. 1):258 (Abstr.) 1989.

Cromwell, et al. *Journal of Animal Science* 70:1404-1416. 1992.

Day, B. N., et al. In *Biotechnology for control of growth and product quality in swine. Effect on reproduction and lactation.* P. Van der Wal, Nieuwhof and Politek (Editors). Wageningen Agricultural University, Wageningen, Netherlands. 1989.

Fedler, C. A., et al. *Journal of Animal Science* 69 (Suppl. 1):347 (Abstr.) 1991.

Prusa, K. J., et al. *Journal of Animal Science* 69 (Suppl. 1):344 (Abstr.) 1991.

Prusa, K. J., and C. A. Fedler. *ISU Swine Research Report*. AS 615. Iowa State University, Ames, Iowa. 1990.

Steele, N.C., et al. In *Biotechnology for control of growth and product quality in swine. Impact on performance and grading.* P. Van der Wal, Nieuwhof and Politek (Editors). Wageningen Agricultural University, Wageningen, Netherlands. 1989.

Zimmerman, D. "Growth Enhancers" In *Proceedings on New Swine Growth Enhancers*, December 6, 1989, Ames, Iowa.

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Proceedings on New Swine Growth Enhancers, December 6, 1989, Ames, Iowa. Available at Parks Library, Iowa State University, Ames, Iowa 50011.

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