pork industry handbook

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Porcine Stress Syndrome

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The porcine stress syndrome (PSS) is a nonpathological disorder that was a major concern to pork producers 10-15 years ago but has been less of a concern recently. The disorder, when present, is usually associated with heavily muscled animals and results in sudden unexplained death losses. Animals having PSS often show signs of nervousness and may have muscle tremors indicated by a rapid tremor of the tail. When these animals are exposed to a stressful situation such as a change in surroundings, a sudden change in the weather, vaccination, castration, estrus or mating, they often respond by becoming overly excited and developing blotches on their skin and muscle rigidity followed by rapid, labored breathing. Their body temperature also begins to rise and they begin to show signs of heat stress even in cold weather. At this point, many producers have attempted to save their animals by spraying with water, but the condition progresses so rapidly that it is virtually impossible to cool the animal fast enough.

Death losses from PSS usually occur during the process of sorting and delivering animals for slaughter. In addition, death losses are higher in the summer months when temperatures are higher, because these animals are unable to rid themselves of body heat. Research has revealed many characteristics of these animals. Some of these findings will be summarized in this fact sheet.

Genetic Factors

First, it should be established that no breed is entirely free of the PSS problem and, likewise, no breed can be categorically termed stress-susceptible. Current theories suggest that the genes controlling the PSS trait are recessive in that both the sire and the dam must be carriers of the gene or genes responsible in order to get stress-susceptible offspring. Therefore, if there is a problem in the herd, the quickest and most economical step is to replace the sire with one you can confidently predict is not stress-susceptible or a carrier of the disorder. Although the PSS condition is sometimes found in animals with superior muscling, it is not necessary to sacrifice carcass merit for freedom from the PSS problem. Instead, one should incorporate meat type animals into the breeding herd that do not appear to be of the PSS type.

Tests for PSS

It is now possible to objectively evaluate candidates for the breeding herd by using one of two tests. The first test involves catching a small drop of blood on a special card* or in a test tube and analyzing for creatine phosphokinase (CPK), a serum enzyme that is abnormally high in PSS swine. The serum test requires submitting the blood sample to a hospital or laboratory with CPK testing capability. It is important that the blood obtained for these tests be drawn at least 2 and preferably 8-12 hours following a physical stress such as a 100-yard run or 5-mile truck ride. Second, the blood must be taken from an ear vein or some other superficial vein so the blood sample is not contaminated with muscle tissue. Third, exercise care in handling the animals since test results will be inflated if the animal has sustained muscle bruising from fighting or harsh treatment prior to sampling.

* Genetic Information Systems, Box 515, Elk Grove Village, Illinois, 60007.

A second test is a bit more involved and requires some specialized equipment. In this test the pig is anesthetized with halothane. Animals that are the PSS type respond to the halothane anesthesia by showing signs of extreme muscle rigidity within 3 minutes from the start of the treatment. Occasionally, an animal that does not respond within this brief period will respond to a longer treatment, but this is seldom the case. This test provides immediate results, but the equipment involved is expensive and the operator requires training. Halothane levels of 3-6% and oxygen flow rates of 1-2 liters per minute administered by a closed system, rebreathing anesthetic machine have produced successful results. The gas is delivered to the pig via a large-animal face mask. The rear limbs are monitored carefully, and the mask is removed immediately upon observing muscle rigidity. The test is generally regarded safe for young pigs; however, results are not repeatable in pigs under 7 weeks of age. Although the test is accurate in older animals, the risk of death due to overexposure increases with the age of the animal.

Blood typing used in conjunction with the halothane test offers great promise in identifying both PSS animals and the carriers of the gene. Researchers have discovered that two blood group locations or loci, called H and S, and three other loci, called Phi, Pgd, and Po-2, are contained on the same chromosome that carries the halothane response gene. Two or more different genes (alleles) are known for each location. Since these genes are all closely linked to the halothane gene, all of the genetic factors on a single chromosome are likely to be inherited together as a single block. Having a knowledge of which of these genes are linked to the stress gene in positive-testing animals permits one to discern which littermates carry only one (carrier) undesirable gene and which contain none. This testing procedure is now in widespread use in Sweden. U.S. researchers are currently modifying the procedure for field use.

Other tests to identify PSS animals have been proposed but have not been as reliable as the tests described. These tests include visual appraisal for the degree of muscling and response to stressors, the increase in blood acidity after the animals have been stressed, the steroid hormone binding capacity of a serum protein, and the level of metabolites in muscle samples taken from live pigs. These tests appeared to hold some promise at various times during the past ten years. However, each test apparently indicated a related response or indicator of the PSS condition rather than the key reactions. As a result, these tests have not been as reliable as the serum enzyme or halothane tests.

What Makes Some Swine Stress-Susceptible?

Although the true cause of PSS is not known at this time, researchers have learned many things about the problem. PSS pigs cannot cope with stressful situations. When exposed to a stress, they undergo several reactions, including a very rapid depletion of their muscle energy stores. As their muscle energy stores are being depleted, there is also a corresponding increase in lactic acid in both the muscle and blood. Normal pigs can remove the lactic acid from the muscle and blood fast enough to prevent excessive build-up; however, PSS pigs have certain circulatory abnormalities that slow the removal of lactic acid from the muscle. Therefore, after a stress, the levels of lactic acid increase in PSS pigs; this is followed by a corresponding increase in blood acidity creating a condition known as metabolic acidosis. Accompanying this condition is a build-up of heat due to a wasteful process of utilizing the muscle glycogen for energy.

PSS pigs have a higher rate of metabolism under resting conditions than normal pigs. This is believed to be due (partially) to an increase in the utilization of hormones from the thyroid gland. The PSS pigs also have a high production of metabolic hormones from the adrenal and pituitary glands.

Since pigs with a high metabolic rate might be expected to have low quantities of backfat, it appears that the condition may be the result of the selection pressure for heavy muscling, which in turn placed heavy emphasis on animals that had increased levels of endocrine activity. It is also likely that during the selection for lean animals with high levels of metabolic activity, a genetic defect occurred rendering some of them susceptible to halothane anesthesia. Pigs in which the PSS condition has been experimentally induced with pituitary hormones appear to be stress-susceptible but do not become sensitive to halothane. It is therefore possible that some stress-susceptible pigs will not respond to the halothane test.

Relation of the PSS to Meat Quality

Much has been said about the use of pork quality estimates when selecting breeding stock. It is true that many PSS animals will yield poor quality carcasses that have pale, soft, and watery muscle. However, not all animals that produce normal quality carcasses are free of PSS. The quality of the pork carcasses is the result of the genetic makeup of the animal and the conditions under which the animal is slaughtered.

It has been demonstrated that most low-quality PSE (pale, soft, and exudative) pork products are the end results of PSS. Research shows the two problems to be closely related. Those animals that are stress-susceptible may die enroute to market or, if they survive until slaughter, produce a high incidence of PSE muscle.

High-quality uncured pork is greyish pink in color, firm in texture, relatively free of surface juices, and it contains modest amounts of marbling. These characteristics result in a juicy, tender, flavorful, nutritious product when it is properly cooked. In addition, high-quality pork will retain most of its juices during cutting, packaging, freezing, and cooking and also during curing, smoking, and emulsifying in the making of manufactured products.

On the other hand, PSE pork is low in quality for the following reasons:

- It is soft, mushy, loose textured, pale, and unappealing.
- The muscles become acidic, especially during early stages after death, and consequently the proteins lose their ability to retain juices.
- The condition appears more frequently in the loin and outer ham muscles, giving a two-toned effect in many pork cuts.
- Affected muscles appear to have little or no marbling.
- In the unprocessed fresh condition, it releases juices during cutting and handling as well as in the retail

package, becomes unattractive to consumers, and has a shorter shelf life than normal pork. These lost juices contain nutritious vitamins, minerals, and proteins.

- When used for manufactured products (smoked cuts, sausage products), it shrinks excessively (about 3% units above normal for fully cooked hams), lacks uniform cured color, shows separation of individual muscles, and may have a dry taste.
- Frozen cuts lose excessive amounts of juice upon thawing.

In some instances PSS pigs do not produce PSE muscle. Several factors may interfere with the usually close relationship. For example, the particular stage of stress response developed by the pig at the moment of slaughter will dictate the conditions within the muscles. If an animal is stress-susceptible but survives a stress that occurs well in advance of slaughter, the muscles may be depleted of their energy reserves. In this instance the meat may appear dark, firm, and dry because very little acid is produced after death. The dark muscle condition is undesirable in appearance, but it does not have the other disadvantages of PSE muscle. If conditions are right, PSS pigs can yield normal appearing muscle. These complicating factors suggest that it is more reliable to base animal selection on direct measurements on the animals rather than on meat quality characteristics of their dead littermates.

Preslaughter Handling Practices and Prevention of PSE Pork

Some conditions of the environment may be comfortable to a stress-resistant animal and stressful to the pig with PSS. Consequently, it may be impossible to handle pigs under practical conditions without imposing some stress.

Some of the undesirable meat characteristics can be minimized by observing some simple management practices at marketing time. The following are some suggestions for reducing losses associated with handling market hogs:

- Avoid crowding in holding pens and trucks.
- Avoid excitement and the opportunity for fighting. Don't mix pigs that have not been reared together. When handling pigs, treat them quietly at all times and refrain from use of an electric prod.
- Avoid extremes in temperature or other environmental conditions. Don't move pigs during the hottest part of the day.
- Use general precautions in all phases of the marketing process; that is, don't require pigs to walk long distances; avoid driving pigs over slick surfaces; don't feed pigs 12-24 hours prior to marketing; spread the stress over long periods, and allow time for adjustment.