What is PG600®?

PG600® contains a combination of two hormones that have been approved worldwide for use in swine for inducing estrus. Much of the early research performed with PG600® was done in the late 60’s and early 70’s. The manufacturer of PG600® (Intervet, Millsboro, DE) perceived the benefit from this hormone combination and began development and testing for approval on a worldwide basis.

The hormone combination originates from purification of one hormone from the serum of pregnant mares (PMSG) during the first third of pregnancy. The other hormone, human Chorionic Gonadotropin (hCG) is purified from the urine of pregnant women in their first trimester of pregnancy. Both of these hormones are metabolized and no residual hormone or detrimental effects have been detected in slaughter animals. Therefore, there is no required withdrawal time for the drug prior to slaughter.

The drug can be purchased in either single or five dose bottles. Each single dose contains a standardized biological activity of each hormone (400 international units or IU of PMSG and 200 IU of hCG). The two hormones are delivered in a dry powdered form in a single sterile bottle with the sterile physiological diluent in a separate bottle. The hormone is stored refrigerated in an unmixed state until ready for use. When ready to use, five cc of diluent are added for each dose of PG600® and injected intramuscularly (i.m.) in the USA, and either i.m. or subcutaneously (s.c.) in other parts of the world.

Introduction

PG600® is a hormone preparation that has been approved for induction of estrus in swine since 1972. Most producers who have experimented with the drug have had variable results ranging from excellent to poor estrus induction responses. This variation in effectiveness has caused concerns and confusion regarding its use. This article attempts to explain why its effectiveness can be variable and why appropriate and inappropriate situations arise for its use. We also report some of the most common problems and questions regarding the routine use of PG600® in the swine breeding herd.

How does PG600® induce estrus?

The combination of hormones in each injection is able to stimulate follicles (which contain eggs) on the ovary, to grow. These follicles produce estrogen when they grow, and when enough estrogen is in the blood, estrus or the standing response is observed in the presence of a boar.

Are there any requirements for PG600® to work?

Yes. For the drug combination to work effectively, the gilts must be near the time of natural puberty (both age and weight) but not yet have reached puberty. Age appears to be even more important than weight.

What happens if gilts that are already cycling are injected?

In gilts that have already cycled, fol-
Follicles grow and ovulate (release eggs at estrus) and then change into structures on the ovary called corpora lutea (CL) that produce a hormone called progesterone. Progesterone is produced for 13-14 days of the estrous cycle. Progesterone is important for maintaining pregnancy but also prevents any further expression of estrous behavior. Therefore if gilts are already cycling and are given PG600®, there is a great chance (~70%) that they will have progesterone and although they may grow and ovulate follicles, they will fail to express estrus.

Will all prepubertal gilts near the correct age and weight show estrus if injected?

Unfortunately, no. For reasons that are not clear, only approximately 50-60% of females show estrus even when age and weight are optimal. Many factors may be involved in this phenomenon and several research studies strongly suggest the influence of season, genetics, housing, nutrition and body condition, and site of injection.

Can you increase the dose and get a better response?

There is limited data on the benefits of a higher dose in pubertal estrus induction. A note of caution: when doses of either hormone become too excessive, the incidence of cystic ovaries may become problematic.

If gilts fail to show estrus within a week or two after a first injection, should I give them another shot?

This is probably the most common question asked regarding PG600®. The answer is no. The reason for this is that a some percentage of gilts actually ovulate after injection of PG600® but fail to show estrus. A second injection would induce new ovulations and CL, and would result in even a greater delay to next estrus.

Can PG600® be used on sows?

Yes, although this is extra-label use. There have been numerous research studies involving the injection of PG600® to sows at weaning. In most cases, there are significant improvements in the percent of sows that return to estrus over seasons and also a reduction in the time interval from weaning to estrus by ~1 day.

What estrus induction rates can I expect?

Generally between 50-60% of gilts are induced to express estrus. However, the range can vary from as low as 20% to as high as 100%.

When will estrus occur after injection?

This is one of the least variable components of the PG600® response. For those prepubertal gilts and weaned sows that express estrus, most (>90%) show estrus within 4-6 days after the injection.

What should I do with those gilts or sows that have not expressed estrus by 3 weeks after the 1st PG600® injection?

For females that are anestrus 3 weeks after the initial shot, a 2nd PG600® shot has been shown to induce ~50% of these into estrus within a week.

Can you breed gilts and sows after the induced estrus?

This is probably the most difficult question to answer due to the number of conflicting reports. On the negative side, in gilts, ovulation rates vary from very low (0-5 eggs) to superovulation (25-70 eggs). Many reports indicate that females induced into early puberty fail to maintain cyclic activity and pregnancy. In gilts and sows, although a greater percent show estrus after injection, farrowing rates and litter sizes are reduced or not different when compared to gilts mated at 2nd estrus or compared to untreated sows at weaning. On the positive side however, other reports indicate that gilts bred at the induced heat can show farrowing rates in excess of 80% and litter sizes between 9-10 pigs. In weaned sows, PG600® has been reported to produce greater numbers of pigs compared to untreated sows.

Recommendations on how to optimize the use of PG600®

Although there are obviously some concerns, the use of PG600® can be quite beneficial to the performance of the breeding herd.

⇒ Firstly, for gilts it will be important know the average or expected age of puberty. Treat these females approximately 2-3 weeks before the expected onset of pubertal estrus.

⇒ Secondly, try not to breed on 1st
estrus. Generally speaking, many females that are treated much earlier than their natural age at puberty are the ones that run the greatest risk of failing to cycle a second time and failing to maintain pregnancy. Most gilts will express a 2nd estrus approximately 20-21 days after the 1st induced estrus. Breeding at this second heat has been shown to improve farrowing rates and litter sizes compared to mating at the 1st induced estrus and should eliminate any problems with low or excessively high numbers of eggs ovulated.

⇒ Thirdly, it is important to provide adequate boar exposure after administering the hormone to allow accurate behavioral stimulation, and detection of estrus.

◊ In the sow herd, the beneficial uses of PG600® at weaning are still not clear. The added expense of the drug seems to be outweighed by the greater numbers of sows that are mated. However, confusion regarding the conflicting reports about improvements, little or no change in farrowing rate, and reports of improvements and even reductions in litter size leads us to the conclusion that further research is needed to investigate why greater numbers of sows may actually express estrus but fail to farrow, before recommendations regarding use of PG600® can be suggested for the sow herd.

◆ In gilts and sows, accumulating evidence suggests that the subcutaneous method approved for use overseas may be beneficial for improving the estrus and ovulatory responses compared to intramuscular administration. However, in the USA, this is considered extra-label use, and a veterinarian should be consulted.

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What are the advantages, if any, of chelated or complex trace minerals versus regular trace minerals in swine diets?

This is an age-old question. There is a paper in the J. Animal Science, Vol. 37:95-103 published in 1973 entitled "Chelated Trace Minerals for G-F Swine" that concludes that chelated trace minerals are as good as normal trace minerals if fed at the level that meets the pigs nutrient (trace mineral) requirement. And the debate has gone on since.

Many claims have been made and are made for the benefit of chelated or complex trace minerals. One is the greater physical stability, which reduces the tendency for trace minerals to segregate in the feed. Another advantage is for less oxidation of vitamins and minerals and greater availability. Recent research has shown that chelated minerals will be 0 to 15 percent more available which will decrease the potential concern for excess mineral excretion into the environment. However, their cost may be two to three times greater than those of non-chelated minerals. Therefore, the costs of chelated or complex trace minerals must be examined before adding them to swine diets.

**Is there an advantage to acidification of starter pig diets?**

The mechanism of action of supplementing inorganic or organic acids to pig starter diets is not clear, but it may be related to a reduction in pH in the upper intestinal tract, thereby reducing the potential for proliferation of undesirable microorganisms in the stomach and small intestine. (1998 NRC Nutrient Requirements of Swine). Most hostile bacteria (pathogens) will not multiply below a pH of about 4.2 (See information below).

**Optimum pH Gut Levels for Pathogen Growth:**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Optimum pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>6.0 - 8.0</td>
</tr>
<tr>
<td>Streptococci</td>
<td>6.0 - 7.5</td>
</tr>
<tr>
<td>Salmonella</td>
<td>6.0 - 7.5</td>
</tr>
<tr>
<td>Staphylococci</td>
<td>6.8 - 7.5</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>6.6 - 7.0</td>
</tr>
</tbody>
</table>

If pH is 4.0 there is no growth of the above pathogens; target is to get as close to pH 3.0 as possible. But the piglet struggles to maintain pH 5.0, which is not quite good enough to knock out the bacteria.

Listed below are typical acidity levels (pH) in the digestive tract of piglets 7-33 lbs.

<table>
<thead>
<tr>
<th>Region</th>
<th>pH Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>2.0 to 5.0</td>
</tr>
<tr>
<td>Duodenum</td>
<td>4.0 to 6.0</td>
</tr>
<tr>
<td>Small intestine</td>
<td>4.0 to 6.0</td>
</tr>
<tr>
<td>Ileum</td>
<td>6.5 to 7.5</td>
</tr>
<tr>
<td>Cecum</td>
<td>5.5 to 6.5</td>
</tr>
<tr>
<td>Colon</td>
<td>6.5 to 7.0</td>
</tr>
</tbody>
</table>

Generally the piglet up to 25 pounds struggles to maintain enough stomach acid. If pH is more than 4 in the stomach, protein digestion is difficult as the protein splitting enzymes do not work properly. There is much evidence to support the hypothesis that maintenance of low stomach pH is critical to the health and productivity of weanling pigs. In young pigs the acidification of stomach contents is mediated by both hydrochloric and lactic acids. Hydrochloric acid is secreted by the gastric mucosa; lactic acid is produced by lactobacillus organisms resident in the stomach.
There is abundant evidence that acid production is inadequate in the young pigs and that the young pig will respond to diet acidification. Digestion, the process of reducing complex chemical molecules to simple constituents which can be absorbed by the animal, is mediated largely by the enzymes produced by various structures associated with the gastrointestinal tract. When the output of enzyme or functional environment for the enzyme is inadequate then digestion is incomplete. Dr. Bob Easter, in his work on acidification of starter diets, indicates that there are at least three factors that account for inadequate digestion in early weaned pigs: behavior, gastric acid production, and intestinal and pancreatic enzyme secretion.

When suckling, the pig can acidify stomach contents using lactic acid produced from milk lactose. This is not available to pigs weaned to a diet devoid of lactose. (Thus, the reason for adding lactose to SEW and Phase I diets for early-weaned pigs). For the weaned pig, it is essential that the stomach pH remains low (< 4.2) in order to initiate protein digestion and provide a barrier against the passage of many different bacterial species into the small intestine.

In addition to Dr. Easter's work here at the University of Illinois, the inclusion of organic acids (fumaric and citric acid) in dry feeds for weanling pigs has been studied in Germany, England and Canada with positive benefits. However, the magnitude of the response appears to be related to age and nature of the diet. The greatest improvement in performance is seen just after weaning and the response declines with age. Pigs fed a milk-based diet (whey, dried skim milk, lactose) respond less to acidification than do pigs that are fed a cereal based diet. These findings confirm the hypothesis that (a) young pigs have limited acidification capability, and (b) that pigs fed milk-based diets benefit from lactic acid formation in the stomach. In the studies conducted here at the University of Illinois, fumaric acid and citric acid were equally capable of improving growth performance of weaned pigs. These studies also found an interaction between the acid response and diet type. The response to dietary acidification was greater in pigs offered simple corn/soybean meal fortified diets than those fed complex diets (corn, SBM and dried skim milk). In the Illinois studies the optimal level of dietary inclusion for fumaric or citric acid was 2-3% of the diet. Fumaric acid was the preferred dietary acidifier since it was significantly lower in cost than citric acid.