Induction and Synchronization of Estrus in Prepuberal Gilts and Anestrous Sows by a PMSG/HCG-Compound

Summary
This paper deals with the influence of a PMSG/HCG-compound (400 IU PMSG and 200 IU HCG in one dose) on the estrus onset in prepuberal gilts and in anestrous sows and gilts. The results of five different experiments are reported.

Introduction
For economic pig production maximum reproductive efficiency is a basic postulate. It can be achieved through early breeding of gilts, high conception rates, large litter size, low post-natal losses, short lactation periods, high conception rates after early weaning and low frequency of anestrous animals. Higher profits can be expected when estrus, insemination and farrowing are synchronized in larger groups of animals. Synchronization of estrus in pigs seems to be achieved with the application of a compound consisting of small amounts of PMSG and HCG (400 IU: 200 IU) as demonstrated by Schilling, Cerne and Minar (1971), Schilling and Minar (1971), Cerne and Schilling (1972). This new compound can replace Metalllibure which is no longer available (Polge, 1971). Progestogens failed to synchronize estrus in pigs (Ulberg, Grummer and Casida, 1951; Winzenried, 1969). Relatively high doses of gonadotropins have been used for induction of estrus in gilts—500 to 2,000 IU of PMSG and 500 to 750 IU of HCG (Dziuk, 1965; Dziuk and Polge, 1965). For treatment of anestrus, the androgen-estrogen combination suites (Jochle, et al., 1967) and the gonadotropin-estrogen compound Prolan-O1 “S” (Cerne, 1966; Doplihar, 1966) or PMSG and HCG (Peters, et al.,1965) have been used with different degrees of success.

Materials and Methods
Five experiments were carried out: Experiments A, C and E at one Yugoslavian industrial pig farm with more than 2,500 Swedish Landrace breeding sows. All breeding animals were carefully selected, and in the process of continuous pig production, they were kept in large groups. The lactation period lasted four weeks. In experiment B, unselected German Landrace gilts were used and it may be noted that in previous experiments (Schilling and Minar, 1971) only five to 10 percent of the gilts of this breed had reached puberty before 6.5 months of age. Experiment D included 28 anestrous sows of the same breed. All experimental animals were treated s/c with one dose of PMSG/HCG-compound (5 mL: 400 IU PMSG + 200 IU HCG).

Estrus was detected with teaser boars and with the “Detest”-equipment (Cerne, 1968). Inseminations were carried out with fresh diluted semen on the first and second days of estrus.

Caution: Treatment will not induce estrus in gilts that have already reached puberty (begun to cycle). Gilts that are less than five and one-half months of age or that weigh less than 85 kg (187 lb.) may not be mature enough to continue normal estrus cycles or maintain a normal pregnancy to full term after treatment. Treatment will not induce estrus in sows that are returning to estrus normally three to seven days after weaning. Delayed return to estrus is most prevalent after the first litter; the effectiveness of P.G. 600 has not been established after later litters. Delayed return to estrus often occurs during periods of adverse environmental conditions, and sows mated under such conditions may farrow smaller than normal litters.

For complete safety information on P.G. 600 use, see accompanying product package insert.
Results

Induction of Estrus, and Conception Rates in Prepuberal Gilts

Experiment A

One-hundred-and-twenty prepuberal Swedish Landrace gilts classified into four groups by age (5 to 6.5 months) were injected with one dose of the PMSG/HCG-compound. Onset of estrus and conception rates (C.R.) were compared with those of the same number of gilts in four control groups (Table 1). Ninety-three to 100 percent of the treated animals came into estrus three to seven days post-injection; 90, 93 and 100 percent of the non-inseminated gilts (Groups A, B, D) came into estrus again—well synchronized—after 21 days (±2 days), 86 percent at the third cycle (Group A). In the control animals estrus was not observed before 6 months of age; 33 percent showed estrous symptoms between 6 and 6.5 months (Group C). The conception rate of the experimental animals was high: more than 80 percent of the inseminated gilts conceived at the first induced cycle (82.1 percent, Group C). Of all treated animals, 76.7 percent farrowed after treatment at six months (first cycle, Group C) and 80 percent after injections at 5.5 months (second cycle, Group B) compared with 23.3 and 40 percent of the corresponding control animals. Breeding and farrowing were six to eight weeks earlier. Litter size was normal, though in the treated groups it was always higher than in the controls.

Experiment B

Thirty-five unselected prepuberal German Landrace gilts, 5.5 to 6 months old, were injected with the hormonal compound. All were inseminated on the fourth and fifth day after treatment regardless of estrous symptoms, and slaughtered 30 days later. As shown in Table 2, in 80 percent of the gilts sexual maturity was induced by hormonal treatment. Eighty-two percent of the mature animals, or 66 percent of all treated animals were pregnant. In 14 percent of the nonpregnant animals the time of insemination probably did not correspond to the time of ovulation. The number of corpora lutea (average 11.6) was as high as in gilts at the onset of puberty (Schilling and Minar, 1971). Embryonic mortality and loss of eggs at Day 30 of pregnancy was 30 percent of which three to four can be assumed to be lost before implantation.

Table 2. Ovulation and Conception Rate in Prepuberal Gilts (30 days after insemination)

<table>
<thead>
<tr>
<th>Treated animals:</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>infantile ovaries</td>
<td>7 (20%)</td>
</tr>
<tr>
<td>mature but non-pregnant</td>
<td>5 (14%)</td>
</tr>
<tr>
<td>pregnant</td>
<td>23 (66%)</td>
</tr>
</tbody>
</table>

In pregnant animal:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>corpora lutea</td>
<td>11.6/animal</td>
</tr>
<tr>
<td>living embryos</td>
<td>8.5/animal</td>
</tr>
<tr>
<td>embryonic mortality</td>
<td>30% (3/4 before implantation)</td>
</tr>
</tbody>
</table>

Table 1. Estrus, and Average Total Litter Size in Prepuberal Gilts Following Treatment

<table>
<thead>
<tr>
<th>Experimental groups</th>
<th>Age at treatment (months)</th>
<th>Percent of gilts in estrus</th>
<th>1st cycle</th>
<th>2nd cycle</th>
<th>3rd cycle</th>
<th>No. of gilts inseminated</th>
<th>No. of cycles</th>
<th>Age</th>
<th>percent of gilts insemin.</th>
<th>percent of all gilts</th>
<th>Average total litter (size range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>5-5.5</td>
<td>100</td>
<td>100</td>
<td>86</td>
<td>26</td>
<td>3</td>
<td>200-210 days</td>
<td>22</td>
<td>100</td>
<td>86.7</td>
<td>10.1(7-14)</td>
</tr>
<tr>
<td>Control</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>–</td>
<td>from day 210</td>
<td>73.3</td>
<td>73.3</td>
<td>9.8(2-12)</td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>5.5</td>
<td>100</td>
<td>90</td>
<td>–</td>
<td>27</td>
<td>2</td>
<td>about day 190</td>
<td>88.8</td>
<td>80.0</td>
<td>9.9(2-13)</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>15</td>
<td>1</td>
<td>from day 190</td>
<td>80.0</td>
<td>40.0</td>
<td>9.3(4-11)</td>
<td></td>
</tr>
<tr>
<td>Group C</td>
<td>6</td>
<td>93</td>
<td>–</td>
<td>–</td>
<td>28</td>
<td>1</td>
<td>about day 180</td>
<td>82.1</td>
<td>76.7</td>
<td>9.8(5-13)</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>10</td>
<td>1</td>
<td>from day 180</td>
<td>70.0</td>
<td>23.3</td>
<td>8.7(2-11)</td>
<td></td>
</tr>
<tr>
<td>Group D</td>
<td>6.5</td>
<td>100</td>
<td>93</td>
<td>–</td>
<td>28</td>
<td>2</td>
<td>about day 220</td>
<td>92.8</td>
<td>86.7</td>
<td>10.4(8-14)</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>–</td>
<td>from day 220</td>
<td>80.0</td>
<td>80.0</td>
<td>9.7(4-13)</td>
<td></td>
</tr>
</tbody>
</table>

30 animals in each group.
Induction and Synchronization of Estrus, and Conception Rates in Anestrous Sows and Gilts

Experiment C

More than 1,000 sows were divided, after four weeks lactation, into 33 groups having 30 to 40 animals in each. In these groups, eight to 40 percent of the animals did not come into estrus during the first 10 days after weaning; 363 anestrous sows from 22 groups were injected with the PMSG/HCG compound on the 11th or 12th day; 118 anestrous sows in 11 groups remained untreated as controls (Table 3).

After treatment, 87.6 percent of the animals showed estrous symptoms and were inseminated at the first and second day of estrus: 77.2 percent of the inseminated sows (67.2 percent of all those treated) farrowed. Of the 118 control animals, only 72 percent came into estrus and were inseminated; 83 percent of them (60 percent of all controls) farrowed. The hormone-induced estrus was easy to detect and well synchronized. Within three to eight days after injection, estrus was detected in 98 percent of the sows (Table 4 and Figure 1). Most of the control sows came into estrus between 20 to 30 days after weaning, and only 22.5 percent during the period from 11 to 20 days. After the end of the next lactation period, 87 percent of those previously treated with the hormonal compound came into estrus within 10 days after weaning without treatment, compared with 63.3 percent of the controls (Table 3).

Table 3. Induction of Estrus and Conception Rates in Anestrous Sows Treated at 11th or 12th Day after Weaning

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Anestrous</th>
<th>In estrus and inseminated</th>
<th>Farrowed</th>
<th>Average total litter size</th>
<th>Normal estrus before next breeding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>No. percent</td>
<td>No.</td>
<td>percent</td>
<td>No. percent</td>
</tr>
<tr>
<td>Treated</td>
<td>22</td>
<td>363</td>
<td>318 (87.6)</td>
<td>244</td>
<td>77.2 (67.2)*</td>
<td>10.5</td>
</tr>
<tr>
<td>Controls</td>
<td>11</td>
<td>118</td>
<td>85 (72.0)</td>
<td>71</td>
<td>83.0 (60.0)*</td>
<td>10.4</td>
</tr>
</tbody>
</table>

*of all animals

Table 4. Percentage of Anestrous Sows Showing Estrus after Treatment on 11th or 12th Day after Weaning

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
<th>In estrus</th>
<th>11.15</th>
<th>16.20</th>
<th>21.25</th>
<th>26.30</th>
<th>31.35</th>
<th>36.40</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>percent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated</td>
<td>363</td>
<td>100.0</td>
<td>318</td>
<td>102</td>
<td>210</td>
<td>3</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>87.6</td>
<td>32.0</td>
<td>66.0</td>
<td>1.0</td>
<td>–</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>210</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>100.0</td>
<td>85</td>
<td>11</td>
<td>8</td>
<td>15</td>
<td>37</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>72.0</td>
<td>13.0</td>
<td>9.5</td>
<td>17.5</td>
<td>43.5</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>6.0</td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Experiment D
Twenty-eight anestrous sows received the hormonal compound between 20 and 100 days after weaning. The lactation period of these sows was six weeks. As shown in Table 5, 89 percent of the treated animals came into estrus mainly between the third and seventh days after injection; 92 percent of the inseminated sows (82.1 percent of all animals) farrowed, on average, 10.6 piglets per litter. In 15 anestrous gilts which showed no estrous symptoms until nine months of age, estrus was induced in 87 percent with one injection, appearing between the third and seventh days. Of the inseminated gilts, 84.6 percent (73.3 percent of all animals) farrowed with an average of 9.3 piglets per litter.

Table 5. Induction of Estrus and Conception Rates in Anestrous Sows and Gilts Treated with PMSG/HCG-Compound

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>In estrus No./Percent</th>
<th>Farrowed No./Percent</th>
<th>Litter size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows</td>
<td>28</td>
<td>25</td>
<td>89.0</td>
<td>23</td>
</tr>
<tr>
<td>Gilts</td>
<td>15</td>
<td>13</td>
<td>87.0</td>
<td>11</td>
</tr>
</tbody>
</table>

*of all animals

Increase of Litter Size in Sub-Fertile Sows

Experiment E
Thirty-seven sows which had below average litter sizes (4.3 ± 1.3 piglets per litter) with no more than six piglets per litter at their second to fourth farrowing, received one injection of the PMSG/HCG-compound on the first day after weaning. All animals came into estrus within three to seven days after treatment, and the average litter size at farrowing of 9.7 ± 1.9 piglets was significantly higher (p < 1%) than in previous litters. At the following pregnancy the same sows, with no hormonal treatment, gave a total average litter size of 5.2 ± 1.7. This indicates that the increase in litter size was due to the treatment.

Discussion

It has been demonstrated that a PMSG/HCG-compound induced follicular development and ovulation in the inactive ovaries of prepuberal gilts as well as in anestrous sows. Most of the treated animals responded with good synchronization of estrus and ovulations, and the induced estrus was highly fertile.

The response to the low dosage (only 400 IU PMSG and 200 IU HCG) was remarkable. Perhaps this combination is particularly favorable and explains the stimulating effect.

The number of growing follicles was normal. All Grafian follicles ovulated and no cysts were observed (see Schilling and Minar. 1971).

These studies indicate the PMSG/HCG-compound could be used to achieve the synchronization of estrous cycles necessary for planned breeding programs in pigs. A single treatment of a group of prepuberal gilts resulted in synchronized estrus (three to five days later), synchronized inseminations and synchronized farrowing.

Those sows which normally do not come into estrus within 10 days after weaning could also be treated with this hormone combination, and a high percentage of them could be bred four to six days later.

In some cases, it may be useful to employ this substance as a “cycle starter” immediately after weaning.

In comparison with other compounds tested, treatment with PMSG/HCG-compound is very cheap and application is simple. Only one injection is necessary. The conception rate is reasonably high and the estrous symptoms are very distinct, which is helpful for diagnosis of estrus where no teaser boar is available.

These investigations may provide some information regarding hereditary factors influencing fecundity. Near doubling of average total litter size in subfertile sows after treatment, and the decrease in average litter size in subsequent farrowings when no hormonal treatment was given, may indicate a hereditary disposition for small litter size. Improvement of litter size seems to be only a temporary “environmental” effect. This compound, therefore, should be used with due caution when selection of breeding animals is being made. It could, however, be advantageous for the induction of synchronized estrus in prepuberal gilts, in anestrous sows, and as a cycle starter after weaning.
References


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Mariensee/Trenthorst, Germany.
P.G. 600®  
(Serum Gonadotropin and Chorionic Gonadotropin)

DESCRIPTION:
Gilts normally reach puberty (begin experiencing normal estrous cycles and exhibiting regular estrus or heat) at any time between six and eight months of age, although some gilts will not have exhibited their first estrus at ten months of age. Age at first estrus is influenced by several factors including breed type, season of the year, environmental conditions, and management practice (Hurtgen, 1986).

Sows normally exhibit estrus three to seven days after weaning their litters; however, some otherwise healthy sows may not exhibit estrus for 30 days or more after weaning (Dial and Britt, 1986).

The causes of delayed return to estrus in healthy sows are poorly understood, but probably include season of the year (so-called seasonal anestrus; Hurtgen, 1979), adverse environmental conditions, such as high ambient temperatures (Love, 1979), and the number of previous litters, because the condition is more prevalent after the first litter than after later litters (Hurtgen, 1986).

P.G. 600 is a combination of serum gonadotropin (Pregnant Mare Serum Gonadotropin or PMSG) and chorionic gonadotropin (Human Chorionic Gonadotropin or HCG) for use in prepuberal gilts (gilts that have not yet exhibited their first estrus) and in sows at weaning. It is supplied in freeze-dried form with sterile diluent for reconstitution.

In gilts and sows, the action of serum gonadotropin is similar to the action of Follicle-Stimulating Hormone (FSH), which is produced by the animals’ anterior pituitary gland. It stimulates the follicles of the ovaries to produce mature ova (eggs), and it promotes the outward signs of estrus (heat).

The action of chorionic-gonadotropin in gilts and sows is similar to the action of Luteinizing Hormone (LH), which is also produced by the animals’ anterior pituitary gland. It causes the release of mature ova from the follicles of the ovaries (ovulation), and it promotes the formation of corpora lutea, which are necessary for the maintenance of pregnancy once the animals have become pregnant.

The combination of serum gonadotropin and chorionic gonadotropin in P.G. 600 induces fertile estrus in most prepuberal gilts and weaned sows three to seven days after administration (Schilling and Cerne, 1972; Britt et al., 1986; Bates et al., 1991). The animals may then be mated or, in the case of gilts, mating may be delayed until the second estrus after treatment.

NOTE: P.G. 600 IS INTENDED AS A MANAGEMENT TOOL TO IMPROVE REPRODUCTIVE EFFICIENCY IN SWINE PRODUCTION OPERATIONS. TO OBTAIN MAXIMUM BENEFIT FROM THIS PRODUCT, ESTRUS DETECTION AND OTHER ASPECTS OF REPRODUCTIVE MANAGEMENT MUST BE ADEQUATE. IF YOU ARE IN DOUBT ABOUT THE ADEQUACY OF YOUR BREEDING PROGRAM, CONSULT YOUR VETERINARIAN.

P.G. 600 is available in two package sizes:

**SINGLE DOSE VIALS** (order Code No. PG-720-1): Five vials containing white freeze-dried powder, plus five vials containing sterile diluent. When reconstituted, each single dose vial (5 mL) of P.G. 600 contains:

- Serum Gonadotropin (PMSG) 400 IU
- Chorionic Gonadotropin (HCG) 200 IU  
  (equivalent to 200 USP Units chorionic gonadotropin)

**FIVE DOSE VIALS** (order Code No. PG-720-5): One vial containing white freeze-dried powder, and one vial containing sterile diluent. When reconstituted, the five dose vial (25 mL) of P.G. 600 contains:

- Serum Gonadotropin (PMSG) 2000 IU
- Chorionic Gonadotropin (HCG) 1000 IU  
  (equivalent to 1000 USP Units chorionic gonadotropin)

INDICATIONS FOR USE:

**PREPUBERAL GILTS**: P.G. 600 is indicated for induction of fertile estrus (heat) in healthy prepuberal (non-cycling) gilts over five and one-half months of age and weighing at least 85 kg (187 lb.).

**SOWS AT WEANING**: P.G. 600 is indicated for induction of estrus in healthy weaned sows experiencing delayed return to estrus.

**CAUTIONS**: Treatment will not induce estrus in gilts that have already reached puberty (begun to cycle). Gilts that are less than five and one-half months of age or that weigh less than 85 kg (187 lb.) may not be mature enough to continue normal estrus cycles or maintain a normal pregnancy to full term after treatment.

Treatment will not induce estrus in sows that are returning to estrus normally three to seven days after weaning. Delayed return to estrus is most prevalent after the first litter; the effectiveness of P.G. 600 has not been established after later litters. Delayed return to estrus often occurs during periods of adverse environmental conditions, and sows mated under such conditions may farrow smaller than normal litters.

**DOSAGE AND ADMINISTRATION**:

One dose (5 mL) of reconstituted P.G. 600, containing 400 IU serum gonadotropin (PMSG) and 200 IU chorionic gonadotropin (HCG), should be injected into the gilt or sow’s neck behind the ear.

Prepuberal gilts should be injected when they are selected for addition to the breeding herd. Sows should be injected at weaning during periods of delayed return to estrus.

**DIRECTIONS FOR USE**:

**SINGLE DOSE VIALS**: Using a sterile syringe and a sterile 0.90 x 38 mm (20 G x 1½”) hypodermic needle, transfer the contents of one vial of sterile diluent (5 mL) into one vial of freeze-dried powder. Shake gently to dissolve the powder. Inject the contents of the vial into the gilt or sow’s neck behind the ear.

**FIVE DOSE VIAL**: Using a sterile syringe and a sterile 0.90 x 38 mm (20 G x 1½”) hypodermic needle, transfer approximately 5 mL of the sterile diluent into the vial of freeze-dried powder. Shake gently to dissolve the powder. Transfer the dissolved product back into the vial of diluent and shake gently to mix. Inject one dose (5 mL) of the reconstituted solution into the gilt or sow’s neck behind the ear.

**STORAGE PRECAUTIONS**: Store at 36–46°F (2–8°C). Once reconstituted, P.G. 600 should be used immediately. Unused solution should be disposed of properly and not stored for future use.

Spent hypodermic needles and syringes generated as a result of the use of this product must be disposed of properly in accordance with all applicable Federal, State and local regulations.

**REFERENCES**:


Induction of fertile estrus in prepuberal gilts with treatment of a combination of Pregnant Mare’s Serum Gonadotropin and Human Chorionic Gonadotropin. Veterinary Record 91:471.