Improved Reproductive Efficiency in Gilts by Intrauterine Infusion of Killed Boar Semen before Breeding

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ABSTRACT : Two separate trials were conducted to determine the effects of uterine priming prior to first breeding and quantify any changes in the reproductive efficiency of gilts. In trial I twelve (12) gilts were randomly assigned to 3 treatments:T1:infusion of distilled water (control), T2: single infusion of killed semen (KS1), and T3: double infusion of killed semen (KS2). Each treatment had 4 breeding gilts which were bred by natural insemination (NI). In trial II, another set of 12 breeding gilts were randomly allotted to the same treatments and were subsequently bred by artificial insemination (AI). Infusions, through the use of AI catheters, were done during the 2nd estrous cycle for T1 and T2, whereas infusions for T3 were made during the 1st and 2nd cycles. Regular breeding was subsequently made during the 3rd estrous cycle. All gilts that returned to cycle were rebred within the 30-day period. In trial I (natural breeding), total piglets born was higher ($p<0.05$) in T2 (12.75 piglets) and T3 (11.75 piglets) than in the control (10.5 piglets). T3 obtained the highest ($p<0.05$) litter size (10.25 piglets) and heaviest litter weight (74.12 kg) at 28 days weaning, followed by T2 (9.80 piglets and 65.0 kg, respectively). The control yielded the lowest ($p<0.05$) litter size (7.50) and the lightest litter weight (47.00 kg) at weaning. For Trial II gilts (artificially inseminated), T3 gave higher ($p<0.05$) litter size born alive (10.88 piglets), total piglets born (11.72 piglets) and live litter weight at birth (15.30 kg) than those of T2 and the control. These results indicate that prebreeding intrauterine infusion of killed boar semen, either single or double, improved the reproductive performance of gilts. ***(Asian-Aust. J. Anim. Sci. 2006. Vol 19, No. 6 : 789-792)***

Key Words : Gilt, Killed Semen, Litter Size, Reproductive Efficiency, Uterine Priming

INTRODUCTION

Reproductive performance of pigs is generally measured in terms of litter size born alive (LSBA) and litter size at weaning (LSW), while reproductive success is measured primarily by piglets produced per sow per year and is dependent upon both farrowing rate and litter size. These parameters are significantly important in evaluating the overall reproductive performance of swine that is commonly measured in terms of piglets produced per sow per year (PPSY). In order to achieve an optimal reproductive rate, both the anatomical and physiological status of the reproductive system of the pig must function properly. The index of output from any breeding herd is reflected in the number of piglets weaned per sow per year that comprises the number of weaned pigs per litter and the number of litters per year, or farrowing frequency. Approaches to improve sow productivity involve maximizing both of these parameters. Reproductive efficiency, therefore, is one of the most important variables in economic efficiency of the swine enterprises. Management practices and breeding intervention that could increase reproductive performance are, therefore, worthy of consideration by all concerned commercial pig producers. Studies in Australia (Bischof et al., 1994a), Korea (Riley, 1999) and the USA (Murray and Grifo, 1986) suggest that the uterine priming of gilts with dead boar semen prior to regular breeding improves subsequent reproductive performance. Increase in litter size in the order of 1.3 to 1.8 pigs have been documented. Riley (1999) reported an improvement in both litter size and farrowing rate.

Reproductive performance in swine could be enhanced by exposure of the uterus to sperm and/or seminal antigens before conception. Limited studies along this line have been conducted and can be found in the literature. More information is needed before swine breeders and producers could use this concept for practical application. The present work was conducted to evaluate the effects of intrauterine infusion of killed boar semen on the reproductive performance of gilts. Specifically, it aimed to quantify any changes in reproductive efficiency as a result of intrauterine exposure to killed boar semen in terms of total pigs born, live pigs born, live litter weight, litter size and litter weight at weaning, and gestation period; and to determine the frequency of killed semen infusions required to elicit a quantifiable improvement in any of the reproductive parameters.

MATERIALS AND METHODS

Animals

The gilts used in this study were progenies of a two-way

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Table 1. Reproductive performance of naturally bred gilts as influenced by prebreeding intrauterine infusion of killed boar semen

Reproductive performance	Treatment		
	T1: distilled water (Control)	T2: single infusion (KS1)	T3: double infusion (KS2)
Litter size born:			
Alive	10.25±1.08	12.75±1.25	11.00±1.15
Mummified	0.00	0.00	0.00
Total pigs born*	10.50^{b}±0.94	12.75^{a}±0.96	11.75^{a}±0.98
Birth weight/piglet (kg)	1.38±0.35	1.32±0.25	1.46±0.38
Live litter weight (kg)	13.82±1.17	16.56±1.19	16.15±1.21
Litter size at day 28*	7.50^{c}±0.68	9.80^{b}±0.78	10.25^{a}±0.82
Litter weight at day 28 (kg)*	47.00^{c}±5.63	65.60^{b}±5.72	74.12^{a}±5.95
Gestation period (days)	113.00±1.71	114.75±1.72	115.00±1.67

[a, b, c] Means followed by common superscripts are not significantly different from each other.
* Significant at 5% level.

cross between Landrace×Large White, while the boars were progenies of Duroc Petrain. All gilts that have started estrus were used from among so many gilts in the farm. Start of the inclusion of gilts to the treatment was made when gilts first come into estrus. Selection of in heat gilts for each treatment was done at random. The gilts were in a group of 6 to 8 pigs per pen prior to the selection.

Collection of semen and infusion:

Semen was collected from donor boars twice a week until enough volume was obtained. The semen samples were pooled and then filtered through multiple layers of cotton gauze and divided into 100 ml aliquots. Thereafter, they were frozen (without any cryopreservation media) to kill the sperms, and were stored at -20°C until needed for infusion. They were thawed prior to infusion. All infusions consisted of 100 ml dead semen using sterile, rubber insemination spirettes and administered when gilts assigned to be infused were in estrus.

Description of treatments

Two trials were conducted. In trial I, 12 gilts, 6 months of age, were allotted randomly and equally into 3 treatment groups following a completely randomized design (CRD). The treatments were summarized as follows:

Treatment 1: Infusion of distilled water (Control)
Treatment 2: Single infusion of killed boar semen (KS1)
Treatment 3: Double infusion of killed boar semen (KS2)

Treatment 1-gilts were infused with 100 ml pure distilled water during the second estrus period. In treatment 2, experimental gilts were infused with 100 ml killed boar semen (KS1) prior to regular breeding. Semen infusion was done during the observed second estrous cycle. Meanwhile, in treatment 3, gilts were infused twice with killed boar semen (KS2). The start of infusion was made during the first observed estrus period. The second infusion was conducted during the succeeding second estrous cycle. This was done so as not to disrupt the regular breeding schedule and other routine management practices strictly implemented in the farm. All the gilts were bred by boars on the third cycle.

In trial II, another group of 12 gilts, 6 months of age, were assigned to the same treatments as above except that during the regular breeding at the third cycle, all the gilts were artificially inseminated. One complete estrous cycle was allowed as interval period before the planned breeding for every gilt in all the treated groups.

Management of experimental animals

All groups of gilts were observed daily during the interval period to determine estrus and to assure that, aside from infusion, all gilts were handled equally. Any experimental animal returning to estrus within a 30-day period was rebred. All animals were kept in confinement, fed and managed according to the standard management practices being followed in the farm. At 7 days before the expected farrowing schedule, they were transferred to individual farrowing stalls until parturition. The following data were gathered: gestation period, total number of pigs born, number of live pigs born, litter weight of live-born pigs, number of live pigs per litter at weaning, and litter weight at weaning.

Statistical analysis

The results of study were analyzed using analysis of variance (ANOVA) technique for a completely randomized design (CRD). Means were compared by least significant differences (LSD) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

Table 1 shows the various reproductive parameters as influenced by intrauterine infusion of killed boar semen in trial I (naturally bred gilts). Significant differences were found among treatment means for total pigs born, litter size and litter weight at weaning (28 days). Total pigs born was higher ($p<0.05$) in treatment 2 (12.75 piglets) and treatment 3 (11.75 piglets) than in the control (10.50 piglets). Treatment 3 obtained the highest ($p<0.05$) litter size (10.25

Table 2. Reproductive performance of artificially inseminated gilts as influenced by prebreeding intrauterine infusion of killed boar semen

Reproductive performance	Treatment		
	T1: distilled water (Control)	T2: single infusion (KS1)	T3: double infusion (KS2)
Litter size born:			
Alive*	9.12^{b}±1.92	8.50^{b}±1.79	10.88^{a}±1.35
Mummified	0.00	0.00	0.50±0.42
Total pigs born*	9.22^{b}±1.95	9.69^{b}±1.85	11.72^{a}±1.75
Birth weight/piglet (kg)	1.50±0.96	1.50±0.65	1.40±0.70
Live litter weight (kg) *	13.82^{b}±1.86	12.48^{b}±1.79	15.30^{a}±1.83
Litter size at day 28 (kg)	8.08±0.98	8.00±0.92	8.92±0.95
Litter weight at day 28 (kg)	57.60±10.27	57.69±10.87	59.96±10.78
Gestation period (days)	115.67±1.58	115.00±1.63	112.33±1.73

[a, b, c] Means followed by common superscripts are not significantly different from each other.

* Significant at 5% level.

piglets) and heaviest litter weight (74.12 kg) at 28 days weaning, followed by treatment 2 (9.80 piglets and 65.60 kg, respectively). The control yielded the lowest ($p<0.05$) litter size (7.50) and the lightest litter weight (47.00 kg) at weaning. Mean values of all other parameters e.g. litters born alive, birth weight per piglet, live litter weight at birth and gestation period had no significant differences This indicates that either single or double infusion of killed boar semen has influenced the total pigs born, litter size and litter weight at weaning of gilts under study.

The effect of intrauterine infusion of killed boar semen on various reproductive parameters of gilts in trial II (artificially inseminated) is shown in Table 2. Significant differences were found in total piglets born alive and total pigs born, and live litter weight at birth. Gilts in treatment 3 (double infusion) gave higher ($p<0.05$) values in terms of litter size born alive (10.88 piglets), total piglets born (11.72 piglets) and live litter weight (15.30 kg) than those in treatment 2 (8.50, 9.69 and 12.48 kg, respectively) and the control (9.12, 9.22 and 13.82 kg, respectively). All other parameters measured like birth weight/piglet, litter size and litter weights at weaning, and gestation period were not significantly different from each other. The above results clearly indicate positive influence of uterine priming prior to regular breeding on important reproductive parameters of gilts.

The major fate of spermatozoa in the reproductive tract is phagocytosis by neutrophils; deposition of sperm induces influx of phagocytic cells (neutrophils; macrophages, and dendritic-like cells) into the uterus (Hansen et al., 1987). This is the main reason why very few live spermatozoa reach the oviduct, the site of fertilization. From several million sperms introduced during breeding, it is believed that only about 70 to 100 participate in the actual fertilization process in pig. Prebreeding uterine priming or sensitization therefore, might have reduced the immunologic action of the uterus against the sperms introduced during regular breeding.

Clarke and Kirby (1966) proposed a very early theory that histocompatibility differences between mother and conceptus might promote fetal survival. Studies in humans (McIntyre and Faulk, 1983) showed that couples in which husband and wife share histocompatibility antigens are much more likely to suffer spontaneous abortions than the general average of the populations. These abortions were associated with the lack of blocking antibody in the maternal sera. Thus, antigenic disparity leading to sensitization, and the production of blocking antibodies can be beneficial to successful reproduction in human beings.

Beer et al. (1975) have shown that in rodents, specific intrauterine sensitization to cellular antigens of an inbred line led to increased litter size when males of the line used for the sensitization sired the litter. Murray et al. (1983) reported that intrauterine treatment with killed semen before insemination resulted in a significant increase in total pigs born, live pigs born, and live litter birth weight. Their study was performed using a pool of semen from all boars in the breeding herd which were subsequently used for breeding the treated gilts. A follow-up work by Murray and Grifo (1986) revealed that killed semen infusion resulted in approximately 1.3 more live pigs per litter at birth. They further claimed that infusion of gilts with killed semen from any boar is as good as specific semen infusion in which the source of infused semen is the same as that for breeding.

Experiments in Australia (Bischof et al., 1994b) and a number of countries including Korea (Riley, 1999) and the USA suggest that the uterine priming of gilts exhibiting estrus with dead boar semen improves subsequent reproductive performance. Increase in litter size in the order of 1.3 to 1.8 pigs have been documented. Riley (1999) has reported an improvement in both litter size and farrowing rate and has theorized that the improvements may extend beyond the first parity.

The observed improvement in reproductive efficiency of gilts in the present study suggests that some aspects of im-

mune stimulation by semen may be beneficial to subsequent pregnancy. The mechanism by which spermatozoa or seminal plasma exerts this effect is unknown. However, in many mammalian females including sows, deposition of seminal fluid into the reproductive tract stimulates a cascade of cellular and molecular alterations. It has been reported that infusion of semen into the pig uterus increased the proliferation of the endometrial luminal epithelium (Bischof et al., 1994b), and resembles a classic inflammatory response (Robertson et al., 1994). Exposure of porcine uterus to boar semen also increases the abundance of macrophages and lymphocytes in the stromal tissues (Engelhardt et al., 1997). Moreover, it has been shown that boar seminal plasma prevents in utero the migration of granulocytes into the uterus of gilts after breeding (Rozeboom et al., 1999) and in vitro inhibits neutrophil chemotaxis (Rozeboom et al., 2001). Alghamdi et al. (2004) reported that in the mare, stallion seminal plasma reduced the proportion of spermatozoa phagocytosed by polymorphonuclear neutrophils (PMNs) by preventing sperm-PMN binding. They also observed increased fertility of mares inseminated with fertile spermatozoa 12 h after induction of uterine inflammation by inoculation of killed spermatozoa. In mice, it was found that certain components of the semen stimulates the uterine cells to produce some growth factors and cytokines (Simmen et al., 1992; Robertson et al., 1994). Thus, growth factors released in response to semen deposition may affect endometrial growth. In the work of Lessard et al. (2003), infusion of whole dead semen into the uterus of gilts during artificial insemination did not affect the levels of different cytokines and growth factors, and the number of alive embryos in the gilt reproductive tract. Nevertheless, they did not discount the potential role of seminal plasma, which contains a high concentration of transforming growth factor-β1 in regulating uterine immune reactions in the first 24 h after insemination and in creating an optimal uterine environment for the development of the embryos. This may also indicate that complexes contained within the boar ejaculate can affect sperm fertility or reproductive processes in the female. The other possible mechanisms by which its use accomplishes improvement in fertility include sperm clearance by the immune system, or improved sperm transport (Rozeboom, 2000).

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