Genetics and Breeding

The use of synthetic seminal plasma (Predil MR-A®) as a method to facilitate procedures with cervical and post-cervical artificial insemination of sows

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Abstract. The aim of this study was to evaluate the effect of seminal synthetic plasma Predil MR-A® as a method to facilitate procedures with cervical and post-cervical two-phase artificial insemination of sows.
In experiment 1 the cervical two-phase artificial insemination was performed with volume of 30 ml of extender in control group or 30 ml of chemical synthetic plasma Predil MR-A® in test group infused followed by the insemination of semen doses. Two semen doses with 3.0 x 10^9 spermatozoa were inseminated in gilts and sows. Results show improved farrowing rates for the test groups with Predil MR-A® in gilts trial - 75.0 % (test group) in comparison to 68.29 % (control group) and in sows trial - 74.07 % (test group) in comparison to 61.90 % (control group). For the litter size expressed as total piglets born per litter and piglets born alive per litter there are also improved figures for the test groups in both trials; 0.58 more total piglets born per litter and 0.50 more piglets born alive per litter in the gilts trial; and 1.12 more total piglets born per litter and 1.28 more piglets born alive per litter in the sows trial. The litter size results point to a tendency in prolificacy improvement versus the control groups, and this improvement is clear in the fecundity index figures in where there are 109.86 piglets more born in total (total piglets born per litter) and 97.89 piglets more born alive (piglets born alive per litter) in the gilts trial and 184.94 piglets more born in total (total piglets born per litter) and 191.20 piglets more born alive (piglets born alive per litter) in the sows trial.
In experiment 2 the cervical insemination with dose 3.0 x 10^9 spermatozoa and post-cervical insemination in combination with Predil MR-A® with dose 1.5 x 10^9 spermatozoa was done. The results of this trial show that the reproductive performance can be maintained with the use of post-cervical insemination in combination with Predil MR-A®, both in farrowing rates, 92.31 % and litter size 13.17 piglets born, when compared with cervical artificial insemination.

Key words: sows, artificial insemination, seminal plasma Predil MR-A®

List of abbreviations
F.R.- percentage of farrowing rate, T.P.B.- total piglets born per litter , P.B.A.- piglets born alive per litter , F.R. x T.P.B.- fecundity index for total piglets born per litter/100 inseminations, F.R. x P.B.A.- fecundity index for piglets born alive per litter/100 inseminations.

Introduction

The use of artificial insemination in pigs has been adopted worldwide as the reproductive method of election at farm level. Nowadays there are different options available for the semen application depending on the place of deposition of the semen in the female genital tract, as follows: (1) deposit the semen into the caudal to middle segment of the cervix – cervical insemination, (2) non-surgically deposit semen into the uterine body – post-cervical or trans-cervical insemination, (3) non-surgically deposit semen "deep" into the uterine horn – intrauterine insemination and (4) surgically deposit spermatozoa approximately 5 cm from the uterotubal junction (Levis, 2004).

In an effort to apply post-cervical insemination, inexpensive technique is developed using spiral or foam tip of catheter with an additional inner cannula. These catheters for trans-cervical insemination consist of a conventional type of disposable catheter, with an additional inner cannula that can extend past the tip of the catheter, allowing semen deposition within the uterine lumen (Roberts and Bilkei, 2005).

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Fig. 1. Position of the catheter in cervical artificial insemination

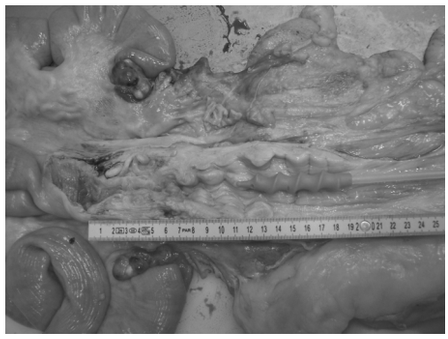
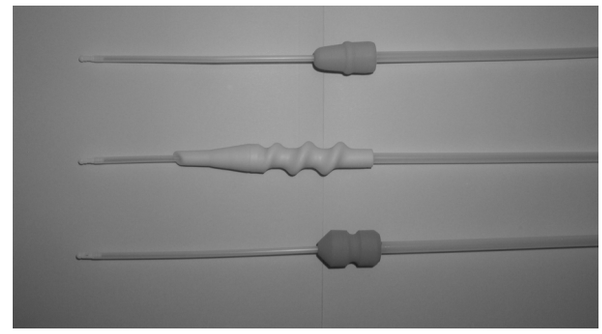


Fig. 2. Position of the catheter in post-cervical artificial insemination

The post-cervical method was launched as a method to improve the reproductive efficiency - increase in fertility and litter size and genetic progress - due to the reduction in the use of elite boars (Levis et al., 2002; Belstra, 2002; Watson and Behan, 2002; Dimitrov et al., 2007; Dimitrov et al., 2007).

A strategy to enhance farrowing rate and litter size of artificially inseminated female pigs is to "stimulate" the uterus and oviduct by adding various compounds to extended boar semen or injecting a compound into the female before insemination. Some of the compounds investigated are oxytocin, analogues of oxytocin, prostaglandins, estrogens, and Predil MR-A®. Although the use of these products may cover up sub-optimal conditions for artificial insemination (poor oestrus detection procedures, use of old sperm cells, inexperienced technicians, and poor insemination techniques), it may be wise for some operations to use these products to increase productivity (Levis, 2002). The studies of some authors (Martin Rillo et al., 1996; Lyczynski et al., 2000) showed, that the use of synthetic seminal plasma Predil MR-A just prior to

Fig. 3. Different models of Spiral and Foam type of catheters with cannula for post-cervical artificial insemination



inseminating the females has a positive effects on farrowing rate and litter size. The use of Predil MR-A® synthetic seminal plasma by means of the two-phase insemination method is a recommended technique to facilitate the insemination procedures and to improve the reproductive results obtained through cervical artificial insemination in pig farms. The trans-cervical infusions of synthetic seminal plasma Predil MR-A® prior to insemination (two-phase insemination method) improved the reproductive results in inseminated sows and gilts, improvement being more significant in sows.

The aim of this study was to evaluate the effect of seminal synthetic plasma Predil MR-A® as a method to facilitate procedures with cervical and post-cervical two-phase artificial insemination of sows.

Material and Methods

Experiment 1. Cervical two-phase artificial insemination with chemical synthesized plasma Predil MR-A® (The chemical composition of Predil MR-A® is a trade secret of KUBUS, S.A., Spain consisting of glucose, potassium chloride, potassium phosphate, magnesium acetate, sodium acetate, hypotaurine and buffer).

In a recent field trial carried out at a Vietnamese farm, where reproductive performance through the cervical artificial insemination method is under optimal reproductive results; the implementation of the two-phase AI method with chemical synthesized plasma (Predil MR-A®) was done.

The aim of this experiment was to pursue better fertility and litter size results by using Predil MR-A® trans-cervical infusions prior to each insemination in gilts and sows (a two-phase insemination method).

Fig. 4. Infusion of 30 ml Predil MR-A®

Fig. 5. Cervical artificial insemination

The experiment took place in a Vietnamese farm where a total of 137 female pigs (commercial synthetic lines) were distributed for two trials; for gilts trial - 89 animals and for sows trial - 48 animals; and for each trial the animals were allocated to two treatment groups: control group and test group. Gilts at first mating stage and sows from different parities were used for the trials.

A two-phase insemination method was performed before each semen dose. As for the control group or test group, a volume of 30 ml of extender in control group or 30 ml of Predil MR-A® in test group was infused followed by the insemination of semen doses. Two semen doses of 100 ml with 3.0 x 10^9 active spermatozoids/dose (total spermatozoa concentration x 0.75) were inseminated in gilts and sows (Fig. 4, Fig.5).

Experiment 2. Post-cervical two-phase artificial insemination with chemical synthesized plasma Predil MR-A®.

To facilitate the insemination procedure with post-cervical artificial insemination method and to test the efficacy of the two-phase AI method with Predil MR-A® in trans-cervical artificial insemination, a recent field trial was carried out in a Spanish farm.

This trial was carried out in a farrow to finish Spanish farm during the first quarter of the year 2008, where 52 weaned sows were randomly allocated in each group:

Control Group: cervical insemination with KUBUS foam catheter and 3.0 x 10^9 spermatozoa / 85 ml dose (cervical artificial insemination).

Test Group: post-cervical insemination with KUBUS foam catheter and KUBUS inner cannula yellow tip in combination with Predil MR-A® at 37º C and 1.5 x 10^9 spermatozoa / 42.50 ml dose (post-cervical artificial insemination).
No gilts were used in this trial.

All sows in the control group were inseminated by the traditional way and the sows in the test group were inseminated following the standard procedure for the post-cervical insemination, but previously infused with 15–20 ml of Predil MR-A® warmed up to 37º C before beginning the introduction of the inner cannula. This procedure speeds up the relaxation of the sow's cervix and makes easier the introduction of the cannula through the cervix rings into the uterus, followed by semen (reduced volume and spermatozoa. concentration dose) deposition and avoiding backflow (Fig. 6 , Fig. 7)

The following parameters were recorded:
Percentage of farrowing rate (F.R.)
Total piglets born per litter (T.P.B.)
Piglets born alive per litter (P.B.A.)
Fecundity index for total piglets born per litter/100 inseminations (F.R. x T.P.B.)
Fecundity index for piglets born alive per litter/100 inseminations (F.R. x P.B.A.)

Statistical analysis was done by SAS (analysis of variance and analysis of frequency).

Fig. 6. Infusion of 15 –20 ml Predil MR-A®

Fig. 7. Inner cannula introduction in post-cervical artificial insemination

Results and Discussion

Results show improved farrowing rates for the test groups with Predil MR-A® in both trials (gilts and sows); in gilts trial (Table 1) 75.0 % (test group) in comparison to 68.29 % (control group) and in sows trial (Table 2) 74.07 % (test group) in comparison to 61.90 % (control group). These results are more significant in the sows group and coincide with former studies (Le Coz, 1996, Reicks et al., 1999) where differences in farrowing rates were found with Predil MR-A® synthetic seminal plasma.

For the litter size expressed as total piglets born per litter and piglets born alive per litter there are also improved figures for the test groups in both trials; 0.58 more total piglets born per litter and 0.50 more piglets born alive per litter in gilts trial (Table 1); and 1.12 more total piglets born per litter and 1.28 more piglets born alive per litter in the sows trial (Table 2).

The litter size results point to a tendency in prolificacy improvement versus the control groups, and this improvement is clear in the fecundity index figures where there are 109.86 piglets more born in total (total piglets born per litter) and 97.89 piglets more born alive (piglets born alive per litter) in the gilts trial (Table 1) and 184.94 piglets more born in total (total piglets born per litter) and 191.20 piglets more born alive (piglets born alive per litter) in the sows trial (Table 2).

In general the results obtained with synthetic seminal plasma Predil MR-A® in the sows trial are more significant in all the studied

parameters than in gilts and the explanation could be that the farrowing rates and litter size in the control group of the sows trial are lower so there is more margin for improvement.

The results from experiment 2 are shown in Table 3.

The results of this trial show that the reproductive performance can be maintained with the use of post-cervical insemination in combination with Predil MR-A®, both in farrowing rates, 92.31 % and litter size 13.17 piglets born, when compared with cervical artificial insemination.

Although in this trial the post-cervical artificial insemination

Table 1. Performance of gilts after cervical two-phase artificial insemination with chemical synthetic plasma (Predil MR-A®).

Trial	n	F.R.	T.P.B.	P.B.A.	Fecundity Index	
		%	mean±SD	mean±SD	F.R.xT.P.B.	F.R.xP.B.A.
Control group	41	68.29	9.89±0.59	9.00±0.67	675.39	614.61
Test group	48	75.00	10.47±0.44	9.50±0.49	785.25	712.50
				Difference	109.86	97.89

Not significant differences between trials

Table 2. Performance of sows after cervical two-phase artificial insemination with chemical synthetic plasma (Predil MR-A®).

Trial	n	F.R.	T.P.B.	P.B.A.	Fecundity Index	
		%	mean±SD	mean±SD	F.R.xT.P.B.	F.R.xP.B.A.
Control group	21	61.90	8.38±1.02	7.92±0.83	518.72	409.24
Test group	27	74.07	9.80±0.80	9.20±0.86	703.66	681.44
				Difference	184.94	191.20

Not significant differences between trials

Table 3. Performance of sows after post-cervical two-phase artificial insemination with chemical synthetic plasma (Predil MR-A®).

Trial	n	F.R.	T.P.B.	P. B.A.	Fecundity Index	
		%	mean±SD	mean±SD	F.R.xT.P.B.	F.R.xP.B.A.
Control group	52	88.46	13.35±1.96	12.26±1.96	1180.94	1084.52
Test group	52	92.31	13.17±1.87	12.08±1.92	1215.72	1115.10
				Difference	34.78	30.58

Not significant differences between trials

sows showed higher fecundity index, no significant differences were found, so, if the farm has good reproductive results in terms of farrowing rates and litter size, by using post-cervical insemination, the improvement can't be expected, but high farrowing rates can be maintained and it is possible to decrease the semen doses to at least one half in both volume and spermatozoa concentration, without affecting the litter size. The use of the two-phase artificial insemination method with synthetic seminal plasma Predil MR-A® facilitates the procedure of insemination with post-cervical artificial insemination, avoiding semen backflow during the insemination process.

At the beginning of post-cervical insemination, there were some studies (Watson and Behand, 2002; Benneman et al., 2004; Mezalira et al., 2005) that demonstrated that acceptable results can be achieved when decreasing the semen dose to one third or less; time and practice (experience) showed us that to obtain acceptable results in terms of farrowing rate and litter size at commercial level, the semen dose must be prepared at a minimum of one half (45 – 50 ml and 1.5 x 10^9 spermatozoa) or no less than one third (30 ml and 1.0 x 10^9 spermatozoa) of volume and spermatozoa concentration, respectively.

The characteristics of the post-cervical artificial insemination

method facilitate semen application, avoiding the possibility of semen backflow during and after the semen application; thus allowing the use of low concentration semen dose. Normally this method was only recommended in sows after first parity due to the problem of passing the inner cannula of the catheter trough the cervix in gilts. Our observations indicate that this problem occurs mainly in immature gilts and it can be avoided if the gilts have enough genital maturation at the first mating period; e.g. > 130 kg live weight, > 240 days of age and > 3rd oestrus; so the size of the genital tract allows to reach the uterus and to facilitate the introduction of the inner cannula through the cervix, and the use of a two-phase insemination method with synthetic seminal plasma (Predil MR-A®) is very useful as there is a dilatation effect in cervix and further effect in the semen transport along the uterus due to mechanical and physiological effects.

In the same way, to facilitate the process of insemination through the cervical artificial insemination technique, the use of the two-phase insemination method has been widely used with the purpose of decreasing semen backflow and enhancing semen transport inside the uterus; furthermore the use of the two-phase artificial insemination method in combination with synthetic seminal plasma Predil MR-A® has also been reported with good results.

When using traditional artificial insemination method and because the tip of the catheter only reaches one third of the cervix, this is the first barrier to be sorted before the semen reaches the uterus. In natural mating the accessory glands of the boars segregate the seminal plasma and the gel fraction that beside the relevant physiological functions, acts as a block after ejaculation, thus avoiding semen backflow; with artificial insemination these natural functions do not exist, and that is why special care must be taken during semen application: warming up of semen previous to artificial insemination to facilitate semen absorption and transit through the uterus, uterine contractions stimulation by back pressure and/or boar presence during insemination to stimulate the oxytocin release that enhances uterine contractions and semen transport, in some systems the application with slight pressure of the semen recipients (bottles, tubes, etc.) to allow the semen to be absorbed by natural contractions of the female, etc. The use of the two-phase artificial insemination method with synthetic seminal plasma is a method that facilitates these insemination necessary functions (enhance cervix dilatation, uterine contractions, avoid backflow and semen transport) with traditional artificial insemination.

Using artificial insemination as a reproductive method rather than naturally mating sows eliminates the boar exposure reducing many of the stimuli associated with natural mating that influence physiological events necessary for successful fertilization. There is also a reduction of a high amount of seminal plasma due to the higher number of doses produced per ejaculate. Dilution of boar ejaculates for use in artificial insemination reduces significant amounts of seminal plasma components which have important regulative functions in fertilization.

Seminal plasma, due to its biochemical composition, contains certain organic and inorganic compounds, which are important for the viability of the spermatozoa and for the fertilization of the ovum. It is a neutral isotonic liquid, which contains potassium, calcium and magnesium that promote spermatozoa vitality, along with chlorides and phosphates, amino acids, vitamins and different enzymes; the presence of some inorganic compounds like fructose, citric acid play an important role in the processes that are important for reproduction.

Nowadays reproductive techniques such as the trans-cervical infusion of synthetic seminal plasma prior to insemination (two-phase insemination method) are used to improve reproductive results in pig herds. Infusion with synthetic seminal plasma prior to insemination has been shown to improve fertilization rate due to an increment of sperm concentration in the oviduct isthmus brought by dilatation effect in the cervix and due to uterine contractions improvement, on the other hand there is also an important effect in spermatozoa motility thus enhancing spermatozoa transport into the uterus.

The use of synthetic seminal plasma prior to artificial insemination introduces in the genital tract of sows and gilts substances which improve fertility. García Ruvalcaba et al. (1997), Reicks (1999), Srisuwan (2001), Ramirez Ovalle (2002) reported a significant improvement in fertility and litter size with the use of synthetic seminal plasma.

With the use of synthetic seminal plasma with the two-phase cervical artificial method some improvements can be achieved as reported in former publications; + 5 % in farrowing rate; significant improvements in litter size are reported when the average results are lower than objectives expected; and for the post-cervical AI when the semen dose maintains minimum concentration and volume.

Conclusion

The use of Predil MR-A® synthetic seminal plasma by means of two-phase insemination method is a recommended technique to facilitate the insemination procedures and improve the reproductive results obtained through cervical artificial insemination in pig farms. The trans-cervical infusions of synthetic seminal plasma Predil MR-A® prior to insemination (two-phase insemination method) improves reproductive results in inseminated sows and gilts, improvement being more significant in sows. The fecundity index improvement is the major benefit obtained with the use of synthetic seminal plasma Predil MR-A® due to the increment in the number of piglets obtained after artificial insemination.

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