

Estrus Synchronization Using Intravaginal Medroxyprogesterone Acetate (MAP), MAP Plus Prostaglandin $F_{2\alpha}$, Controlled Internal Drug Release (CIDR) or CIDR Plus Prostaglandin $F_{2\alpha}$ in Saanen Dairy Goats in Thailand

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ABSTRACT

The objective of this study was to compare the efficiency of medroxyprogesterone acetate (MAP) in the form of impregnated intravaginal sponges with or without Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) and natural progesterone impregnated controlled internal drug release (CIDR) devices with or without $PGF_{2\alpha}$ in dairy Saanen goats in Thailand. Seventy-five Saanen does were divided into five equal groups. The sixty does in Groups 1 to 4 in Experiment 1 were assigned for estrus synchronization using the following intravaginal progestagen techniques: sponges impregnated with MAP in Group 1 ($n=15$), sponges with MAP and intramuscular injection of 125 g $PGF_{2\alpha}$ in Group 2 ($n=15$), progesterone CIDR devices in Group 3 ($n=15$) and progesterone CIDR devices and intramuscular injection of 125 g $PGF_{2\alpha}$ in Group 4 ($n=15$). Intravaginal progestagens were administered for 13 d and the $PGF_{2\alpha}$ was injected on day 13. Estrus responses of does in Groups 1 to 4 were detected from 12 to 60 hr after progestagen withdrawal. In the remaining 15 does of Experiment 2 in Group 5, estrus was synchronized by intravaginal progestagen with MAP for 13 d. Estrus responses of does in Group 5 were detected at 24 and 48 hr after progestagen withdrawal. After estrus synchronization, the estrus does in Groups 1 to 5 were artificially inseminated with frozen semen once within 48–50 hr after progestagen withdrawal. However, for does in estrus in Group 5, the vaginal mucous accumulations were flushed with saline solution before artificial insemination (AI). Pregnancy was detected by ultrasonography on day 60 after AI. The result of Experiment 1 was estrus responses in all does in Groups 1, 2 and 4 but in only 10 does in Group 3. The mean estrus onset times of Groups 1 and 2 were not significantly different (21.0 ± 1.2 and 21.5 ± 1.3 hr, respectively) but were significantly different from those of Groups 3 (18.5 ± 1.9 hours) and 4 (18.6 ± 2.0 hr) ($P < 0.05$). The mean estrus durations of Groups 1 to 4 were not significantly different. Pregnancy ultrasonography revealed no difference in the pregnancy rates among Groups 1 to 4. Experiment 2 resulted in estrus responses in all does in Group 5. Comparison of the pregnancy rates of Groups 1 and 5 showed that Group 5 had a trend of a higher pregnancy rate than Group 1. It can be concluded that the MAP treatment with or without $PGF_{2\alpha}$ had equal efficacy to the CIDR-with- $PGF_{2\alpha}$ treatment, and that the MAP treatment combined with vaginal mucous flushing could possibly increase the conception rate.

Keywords: estrus synchronization, medroxyprogesterone acetate, CIDR, Saanen goat

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INTRODUCTION

Although goats are a relatively new domestic animal in Thailand, they are playing an important role in commercial farming systems. Increasing numbers of goats are being kept in every region of Thailand because of their hardiness (Cheva-Isarakul, 1998). One of the most popular dairy goat breeds in Thailand is the Saanen because it offers several advantages: good mothering ability, high milk production, adaptability, hardiness, and resistance to diseases under local farming conditions and the environment of Thailand (Cheva-Isarakul, 1998). Thus, this breed is well suited for cross-breeding with native Thai goats to improve milk yield and litter size. Such breeding programs can be assisted by using reproductive techniques such as artificial insemination (AI), multiple ovulation and embryo transfer. AI is probably the most practiced technique during both the breeding and nonbreeding seasons of dairy goats. One of the main problems associated with AI is the detection of estrus in does. However, if estrus synchronization can be achieved in breeding dairy goats, the need for estrus detection could be reduced or even eliminated. Intravaginal sponges impregnated with progestagens such as medroxyprogesterone acetate (MAP) or flurogestone acetate (FGA) have been extensively used for estrus synchronization in sheep and goats during the breeding and nonbreeding seasons (Wildeus, 1999; Romano *et al.*, 2000; Romano, 2002). An intramuscular injection of pregnant mare serum gonadotrophin (PMSG) at the same time as sponge withdrawal is used to stimulate follicle growth (Greyling and Van der Nest, 2000; Motlomelo *et al.*, 2002). Some studies have found that these two progestagens were equally effective for estrus synchronization in goats (Smith *et al.*, 1981; Motlomelo *et al.*, 2002; Dogan *et al.*, 2005). Controlled internal drug release (CIDR) devices followed by PMSG have been regularly used in goats for estrus synchronization and fixed-time

AI programs in Thailand (Thavara *et al.*, 2007). The CIDR uses a silicone device that does not absorb vaginal secretions and so induces less foul-smelling discharge when it remains *in situ* (Carlson *et al.*, 1989). Prostaglandin has been injected in combination with progestagens in synchronization protocols in goats and could reduce the period for estrus synchronization from 11 down to 5 d (Wildeus, 1999; Pierson *et al.*, 2001, 2003). Romano (2004) compared CIDR, MAP and FGA treatments plus prostaglandin F_{2α} following progestagen removal and found them to be equally effective in estrus synchronization and enhancing fertility in goats. Sumransap and Ngamkhum (2010) found the use of CIDR or MAP treatments following PMSG for 2 d before progestagen withdrawal to be similar in efficacy in estrus synchronization and achieved similar pregnancy rates after AI in Saanen goats in Thailand.

MATERIALS AND METHODS

The study was conducted on the dairy goat farm of the Embryo Transfer Technology Research Center, Department of Livestock Development, Pakchong district, Nakhon Ratchasima province in northeastern Thailand. A total of 75 pluriparous Saanen goats varying in age between 2 and 5 y were chosen for the study by simple random sampling from a flock. All does had kidded six or more months previously and were not lactating. The animals were kept indoors all day and had access to an open-air run. They were given a concentrated diet with 16% protein each morning, natural grass and hay twice a day (in the afternoon and evening), and had access to water and a mineral lick *ad libitum*. Under their general management schedule, the goats were dewormed and their hooves were trimmed about three times a year. These experiments were approved by the Animal Care and Use Committee, Faculty of Agricultural Technology, King Mongkut's

Institute of Technology Lat Krabang (Project: KMITL0006/2551).

Experiment 1

The 60 does in Experiment 1 were randomly divided into four groups of 15 (Groups 1 to 4). The 15 does in the first group were treated with intravaginal sponges impregnated with 60 mg of MAP (Sincrogest EsponjasTM; Laboratorios Ovejero, Spain) for 13 d. In the second group, each of the 15 does was treated with an intravaginal sponge impregnated with 60 mg of MAP for 13 d and then on day 13 after removal of the sponge, this was followed by an intramuscular injection of 125 µg PGF_{2α} (Cloprostenol; EstrumateTM, Schering-Plough, USA). Immediately after sponge withdrawal, each doe in Groups 1 and 2 received an intramuscular injection of 500 IU PMSG (Sincrogest PMSGTM; Laboratorios Ovejero, Spain). Each doe in the third and fourth groups of 15 does received 300 mg natural progesterone in an impregnated intravaginal CIDR device (natural progesterone; Eazi-BreedTM CIDR sheep and goat device, Pharmacia and Upjohn, Australia) for 13 d followed by an intramuscular injection of 500 IU PMSG (FolligonTM, Intervet, Netherlands) at the time of CIDR device withdrawal. On day 13 after the withdrawal of the CIDR device, only the 15 does in the fourth group were each also given an intramuscular injection of 125 µg PGF_{2α}. Blood samples (10 mL/goat) were collected from all goats in the four groups on days 1, 2 and 23 after progestagen withdrawal, to measure the serum progesterone concentration for monitoring the estrus period after progestagen withdrawal and for detecting pregnancy after AI (at day 21). The serum progesterone concentration levels have been interpreted by many researchers; they validated progesterone concentration levels of 0.1–0.5 ng.mL⁻¹ at estrus (Thorburn and Schneider, 1972; Thibier *et al.*, 1981; Holdsworth *et al.*, 1983) and found that levels under 2.5 ng.mL⁻¹ were indicative of the follicular, or early, phase of the

estrus cycle and that levels equal to or exceeding 2.5 ng.mL⁻¹ indicated pregnancy (Thorburn and Schneider, 1972). Serums were pipetted and stored at -20 °C until assay using micro-luminescence-radioimmunoassay (Progesterone MLRIA, Abbott Laboratories, USA, 2007; sensitivity ≤ 0.1 ng.mL⁻¹ performed by Bangkok RIA Diagnostic Corporation, Limited, Bangkok, Thailand). In addition to the monitoring of the serum progesterone concentration, estrus detection of all does was carried out with the aid of four fertile Saanen bucks every 4 hr from 12 to 60 hr after progestagen withdrawal. For each animal, a behavior observation session to detect estrus was conducted for 1 hr. The bucks were released to mingle with all the does in the four groups for estrus detection. In addition to acceptance of mounting when in close contact with a buck, signals of does in estrus were swelling of the vulva and tail wagging. Estrus duration was defined as the time from the first acceptance of mounting until the time of the last acceptance of mounting within the same estrus period. The does in estrus were separated to be artificially inseminated intracervically once at a fixed time of 48–50 hr following progestagen withdrawal. The number of does in estrus and the onset of estrus and the estrus period for each doe were recorded. Intracervical artificial insemination was performed on each doe in estrus. The presence and appearance of any vaginal discharge in the front of the external os was observed every time before AI. The number of does in each group with large amounts of discharge obscuring the external os was recorded, and this motivated the undertaking of Experiment 2. Each doe was inseminated with Saanen frozen semen in 0.25 mL straws rated at 150 million spermatozoa with at least 60% progressive motile post-thawing. Pregnancy diagnosis was determined using the serum progesterone concentration levels on day 21 after AI (23 d after progestagen withdrawal) and confirmed with the aid of trans-abdominal ultrasonography scanning (Model

Mindray; Version DP-6600 Vet, Mindray Medical International Limited, Shenzhen, China) on day 60 after AI. Pregnancy in the does of each group was expressed as a pregnancy percentage.

Experiment 2

Immediately after the completion of Experiment 1, the 15 does in the fifth group were treated with intravaginal sponges impregnated with 60 mg of MAP (Sincrogest EsponjasTM; Laboratorios Ovejero, Spain). The sponges remained *in situ* for 13 d and immediately after sponge withdrawal, 500 IU PMSG (Sincrogest PMSGTM; Laboratorios Ovejero, Spain) was injected intramuscularly into each doe. Estrus detection was done with the aid of four fertile Saanen bucks on days 1 and 2 after progestagen withdrawal; animal behavior was observed for 1 hr each day. The main signal of does in estrus was acceptance of mounting; a doe standing still to accept mounting was judged to be in estrus and ready for artificial insemination. The does in estrus were separated to be artificially inseminated intracervically once at a fixed time of 48–50 hr following progestagen withdrawal. The external os of the does in estrus was observed a short time before intracervical artificial insemination for detection of any vaginal discharge obscuring the external os. The numbers of does in estrus and of does with vaginal discharge obscuring the external os were recorded. A few minutes before intracervical artificial insemination, the external os of each of the does in estrus in this group was flushed with 25–50 mL of 1.0% saline solution using a speculum, an electric torch, a plastic sheath and a 50 mL syringe in order to clean any vaginal discharge from the external os. Intracervical artificial insemination techniques and Saanen frozen semen preparation were performed as in Experiment 1. Pregnancy diagnosis was undertaken with the aid of ultrasonography scanning at day 60 after AI. Pregnancy in the does of this group was expressed as a pregnancy

percentage.

Statistical analysis

The numbers of does in estrus and of those with vaginal discharge obscuring the external os discharge and the pregnancy rates on day 21 and on day 60 following AI in the experimental groups were compared using the chi-square test for multiple category analysis. When any cell in the chi-square test contained a number less than 5, Fisher's exact test was used for analysis. The significance level was set at $P \leq 0.05$. The average of serum progesterone concentration levels on days 1, 2 and 23 after progestagen withdrawal, the onset of induced estrus and the duration of estrus in all experimental groups were analyzed using analysis of variance and the differences among experimental groups for all statistics were compared using Duncan's method with the level of significance set at $P \leq 0.05$ using SPSS software (SPSS version 10.0 for Windows, SPSS Inc., Chicago, USA).

RESULTS

Experiment 1

The average of serum progesterone concentration levels among does in Groups 1 to 4 on days 1, 2 and 23 after progestagen withdrawal (21 d after AI) are presented in Table 1. In the third group, five does had serum progesterone concentrations greater than 2.5 ng.mL⁻¹ on days 1 and 2 after progestagen withdrawal.

Reproductive performance following synchronization among the goats of the four groups is presented in Table 2. All does (100%) in Groups 1, 2 and 4 showed estrus behavior after progestagen removal, but only 10 does in the third group (66.7%) were in estrus after synchronization (on the basis of serum progesterone levels on days 1 and 2 after progestagen removal being less than or equal to 0.5 ng.mL⁻¹). Thus, the mean times of estrus onset and the mean durations of estrus were

Table 1 Average of serum progesterone concentration levels among goats of the four groups on days 1, 2 and 23 after progestagens withdrawal (21 d after AI).

Treatment group	No. of does	P ₄ concentration levels on day 1	P ₄ concentration levels on day 2	P ₄ concentration levels on day 23
Group 1; MAP+PMSG	15	0.1 ±0.00 ^a	0.11±0.04	1.34±2.77
Group 2; MAP+PMSG+PGF _{2α}	15	0.17±0.13 ^a	0.15±0.09	3.81±4.18
Group 3; CIDR+PMSG	15	3.15±5.16 ^b	2.77±5.08	1.62±2.63
Group 4; CIDR+PMSG+PGF _{2α}	15	0.11±0.04 ^a	0.26±0.15	2.94±4.45

MAP = medroxyprogesterone acetate; PMSG = pregnant mare serum gonadotrophin; PGF_{2α} = Prostaglandin F_{2α};

CIDR = controlled internal drug release.

^{a, b} = Values in same column with different letters as superscripts are significantly different ($P < 0.05$).

Table 2 Reproductive performance in Saanen does after different estrus synchronization treatments.

Treatment group	No. of does in estrus	Does in estrus (%)		Mean of estrus onset (hr)	Mean of estrus duration (hr)
		24 hr after withdrawal	48 hr after withdrawal		
Group 1; MAP+PMSG	15/15	100 ^a	100 ^a	21.0±1.2 ^a	35.0±1.6
Group 2; MAP+PMSG+PGF _{2α}	15/15	100 ^a	100 ^a	21.5±1.3 ^a	35.5±1.3
Group 3; CIDR+PMSG	10/15	66.7 ^b	66.7 ^b	18.5±1.9 ^{b*}	35.1±1.6 [*]
Group 4; CIDR+PMSG+PGF _{2α}	15/15	100 ^a	100 ^a	18.6±2.0 ^b	36.0±2.3

MAP = medroxyprogesterone acetate; PMSG = pregnant mare serum gonadotrophin; PGF_{2α} = Prostaglandin F_{2α};

CIDR = controlled internal drug release.

^{a, b} = Values in same column with different letters as superscripts are significantly different ($P < 0.05$).

* = Mean values were calculated from 10 does displaying estrus behavior after synchronization.

calculated on the basis of the 15 does in Groups 1, 2 and 4 but on the basis of only the 10 does displaying estrus behavior after synchronization in Group 3. The mean intervals from progestagen withdrawal to the onset of induced estrus of Groups 1 and 2 and of Groups 3 and 4 were not significantly different, but groups receiving different treatments, that is, MAP in Groups 1 and 2 and CIDR in Groups 3 and 4, differed significantly. The mean estrus durations of Groups 1, 2, 3 and 4 were not significantly different.

The numbers of does with serum progesterone concentration in excess of 2.5 ng.mL⁻¹ in the pregnancy monitoring on day 21 after fixed-time AI at 48–50 hr after progestagen withdrawal (or at 23 d after progestagen withdrawal) were three (20.0%) in Group 1, seven (46.7%) in Group 2, four (26.7%) in Group 3 and five (33.3%) in Group 4. There was no significant difference

among the four groups. The numbers of does found to be pregnant as determined by ultrasonography on day 60 after AI were two (13.3%) in Group 1, three (20.0%) in Group 2, four (26.7%) in Group 3 and three (20.0%) in Group 4. There was no significant difference among the four groups.

Experiment 2

All 15 does (100%) in Group 5 showed estrus responses on days 1 and 2 after progestagen withdrawal. All the does were examined for vaginal discharge especially in the area of the external os before AI. Table 3 presents the vaginal discharge observation data for Groups 1, 2, 3 and 4 in Experiment 1 and Group 5 in Experiment 2 showing the number of does in estrus having vaginal discharge obscuring the external os and the pregnancy rate on day 60.

Table 3 Vaginal discharge observation in short period after progestagen removal and pregnancy rate following AI.

Treatment group	Number of does in estrus	Number (with percentage in parentheses) of does with vaginal discharge obscuring the external os	Pregnancy rate on day 60 after AI (%)
Group 1; MAP+PMSG	15/15	6/15 (40.0 ^a)	13.3 (2/15)
Group 2; MAP+PMSG+PGF _{2α}	15/15	5/15 (33.3 ^{ab*})	20.0 (3/15)
Group 3; CIDR+PMSG	10/15	1/15 (6.7 ^{bc*})	26.7 (4/15)
Group 4; CIDR+PMSG+PGF _{2α}	15/15	0/15 (0 ^c)	20.0 (3/15)
Group 5; MAP+PMSG (Flushing external os before AI)	15/15	6/15 (40.0 ^a)	33.3 (5/15)

MAP = medroxyprogesterone acetate; PMSG = pregnant mare serum gonadotrophin; PGF_{2α} = Prostaglandin F_{2α};

CIDR = controlled internal drug release.

^{a, b, c} = Values in same column with different letter superscripts were significantly different ($P < 0.05$).

* = Trend of difference ($p=0.068$) for number and percentage of does with vaginal discharge obscuring the external os between Groups 2 and 3.

DISCUSSION

The treatments with MAP *in situ* for 13 d and PMSG on the day of sponge withdrawal and MAP *in situ* for 13 d with PMSG and PGF_{2α} on the day of sponge withdrawal were found to be excellent and equally effective to the treatment protocol with CIDR *in situ* for 13 d with PMSG and PGF_{2α} on the day of device removal for estrus synchronization in Saanen does in Thailand. The estrus response within 24 hr after progestagen removal obtained in these three treatment groups was 100%, which was in agreement with the reports of Wildeus (1999), Motlomelo *et al.* (2002) and Whitley and Jackson (2004), and was significantly different only from the treatment group with the CIDR device *in situ* for 13 d and PMSG on the day of device removal (66.7%). The reason for this difference might be attributed to the timing of estrus synchronization; it may be that 13 days with the CIDR device *in situ* with PMSG treatment on the day of the removal of the device is not optimal for manipulating the follicular phase of does because the treatment length of 13 d is shorter than the 16 d of the luteal phase. Thus at day 13, there were some does (five in this study) in

which the presence of a functional corpus luteum inhibited the estrus response within 60 hr after the end of the CIDR treatment. Thus PGF_{2α} had to be injected to induce luteolysis of the functional corpus luteum to stop the luteal phase (Leboeuf *et al.*, 1998). On the other hand, the treatment with MAP and PMSG induced estrus in 100% of the does due to the fact that MAP is a more potent synthetic progesterone hormone than that used in the CIDR treatment. It could possibly also be more effective than CIDR in inducing negative feedback on GnRH secretion so that does were brought to estrus with the preovulatory follicle and a higher blood estrogen hormone concentration (Robinson *et al.*, 1967). From the current study, it could be concluded that PGF_{2α} together with the CIDR and PMSG treatment for a shorter period than the luteal phase increased the estrus response rate. The mean overall estrus onset for the does in treatment groups with CIDR was significantly earlier than for the does in treatment groups with MAP, similar to the results of the studies of Motlomelo *et al.* (2002) and Romano (2004). The reason for this could be that the solid silicone of CIDR released low progesterone concentrations at withdrawal while the sponges released highly

potent medoxyprogesterone acetate concentrations at removal (Greyling and Brink, 1987). However, the current results showed earlier estrus onset compared to the studies of Motlomelo *et al.* (2002) and Romano (2004). The reason for this discrepancy might be attributed to differences in breed, nutritional status, season, use of PMSG to stimulate follicular growth and the rapid appearance of high serum estrogen concentrations (Zelege *et al.*, 2005). The mean overall durations of estrus in all groups were similar in the current study. Thus, it could be concluded that PGF_{2α} did not influence the duration of estrus, and this is in agreement with previous reports from Motlomelo *et al.* (2002) and Romano (2004). The average of the serum progesterone concentration levels among goats of the Groups 1, 2 and 4 were less than 0.5 ng.mL⁻¹ and significantly different ($P < 0.05$) from the level of Group 3 (3.15 ± 5.16 ng.mL⁻¹) on day 1 but not significantly different from Group 3 (2.77 ± 5.08 ng.mL⁻¹) on day 2 after progestagen withdrawal. The third group had five does with no estrus response after synchronization. Thus, in the current study, the average of the serum progesterone levels in Group 3 on days 1 and 2 after progestagen removal were greater than 2.5 ng.mL⁻¹. The serum progesterone concentrations in MAP- or CIDR-treated does were less than 0.5 ng.mL⁻¹ on days 1 and 2 after progestagen removal. This means that the does were in estrus and ready for fixed time AI (Thorburn and Schneider, 1972; Thibier *et al.*, 1981; Holdsworth *et al.*, 1983). The average serum progesterone concentration levels of Groups 1 to 4 on day 23 after progestagen withdrawal (21 d after AI) were not significantly different. Suspected pregnant does in each group had higher serum progesterone concentrations (greater than 2.5 ng.mL⁻¹, which is indicative of pregnancy), when compared to non-pregnant does on day 21 after AI (Thorburn and Schneider 1972). Pregnancy in Experiment 1 was accurately confirmed by ultrasonography at day 60 following AI. The overall confirmed pregnancy rates of the

groups in Experiment 1 were not significantly different and were relatively low when compared to the previous reports of Motlomelo *et al.* (2002) and Romano (2004). The recorded data on the vaginal discharge observations of Groups 1 to 5 showed there were significant differences with there being a greater number of does with vaginal discharge obscuring the external os in the MAP-treatment groups (Groups 1, 2 and 5) than in the CIDR-treatment groups (Groups 3 and 4) and a trend of difference ($p = 0.068$) in the number of does with more obscuring discharge between Groups 2 and 3. According to the report of Carlson *et al.* (1989), the MAP sponge absorbed vaginal secretions and also induced more discharge than did the CIDR silicone device when inserted *in situ*. When the pregnancy rates at day 60 after AI were compared among Groups 1 to 4, in which none of the experimental does received vaginal flushing, there were no differences in pregnancy rates among the groups. These results are in accordance with earlier reports (Motlomelo *et al.*, 2002; Romano, 2004). The overall pregnancy rate on day 60 of does in Group 5 (33.3%) was the highest among all groups. A comparison of Groups 1 and 5 (which both received the same MAP protocol but differed in that the does of Group 1 received no vaginal flushing whereas those of Group 5 did) showed that Group 5 had a higher pregnancy rate than Group 1. This may have been due to the external os of does in Group 5 having been flushed before AI to clean it and decrease the remaining noninfectious vaginal discharge from the absorbent sponge, thus making it possible for the inseminator to see the external os clearly and conduct intracervical AI accurately. In conclusion, the MAP sponge treatment induced more vaginal discharge than the CIDR silicone device (as also noted by Carlson *et al.*, 1989) and so interfered with intracervical artificial insemination. Therefore, the conditions of Experiment 2, in which the does were treated with vaginal flushing, is possibly associated with the higher pregnancy rate.

CONCLUSIONS

Overall, the progesterone treatment with the MAP/PMSG combination for a short period (13 d) had the most advantages compared to MAP/PMSG plus PGF_{2α} or CIDR/PMSG or CIDR/PMSG plus PGF_{2α} for estrus synchronization in dairy goats. Firstly, the MAP/PMSG treatment was equally effective as the MAP/PMSG-plus-PGF_{2α} and CIDR/PMSG-plus-PGF_{2α} treatments and was more effective than the CIDR/PMSG treatment in synchronizing estrus. Secondly, treatment with MAP/PMSG was more economical since there was no need for PGF_{2α} application. Lastly, the pregnancy rate of does with the MAP/PMSG treatment was similar to that of does receiving the MAP/PMSG-plus-PGF_{2α} and CIDR/PMSG-plus-PGF_{2α} treatments. Moreover, the cleaning of vaginal mucous secretion accumulation helped to facilitate intracervical insemination and could possibly help to increase the conception rate.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation to the Embryo Transfer Technology Research Center, Department of Livestock Development, Thailand and Dr. Rutcharin Limsupavanich.

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