

Efficiency of Intravulval Lip Route of Prostaglandin F_{2α} Administration on Estrus Synchronization in Dairy Cattle

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كفاءة استخدام البروستاجلاندين عن طريق شفة الفرج لمزامنة فترة الشبق في أبقار الحليب

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خلاصة: تم إحداث تزامن فترة الشبق عند أبقار الحليب باستخدام prostaglandin F₂ (PG) analog Estrumate (Animal Health Ltd., Berkhamsted, England, UK; 250 µg/ml of cloprostenol) بإعطاء الهرمون بطريقتين وجرعتين مختلفتين كالاتي: 500 ميكروجرام عن طريق العضلات (الحاكمة) و 125 ميكروجرام عن طريق شفة الفرج (التجربة). تم تلقيح جميع الحيوانات اصطناعياً وتم تحديد فترة الشبق باستخدام نظام الصباح والمساء. كان معدل الحمل لأول تلقيح لجميع الأبقار 70% للحيوانات المقارنة و 54% للحيوانات تحت التجربة. كذلك لم يكن هناك اختلاف معنوي في معدل الحمل لأول تلقيح (P > 0.05) بين سلالات أبقار الفريزيان و أبقار الحليب الأسترالية (52% للفريزيان و 78% لأبقار الحليب الأسترالية). زيادة على ذلك فإن جميع الأبقار في هذه الدراسة قد تم تأكيد حملهن بنهاية موسم التلقيح. يمكن الاستنتاج بأنه من الممكن إحداث تزامن فترة الشبق عند الأبقار باستخدام 125 ميكروجرام من cloprostenol دون تأثير على الخصوبة. تمثل هذه الجرعة ربع الجرعة الموصى بها من قبل الشركة المصنعة.

ABSTRACT: Estrus was synchronized in dairy cattle using the synthetic prostaglandin F_{2α} (PG) analog Estrumate (Coopers Animal Health Ltd., Berkhamsted, England, UK; 250 µg/ml of cloprostenol). PG was administered by two routes at two different doses, 500 µg by im route (control) and 125 µg by intravulval lip (ivu) route (treatment). All animals were bred by artificial insemination (AI) to detected estrus using the am-pm breeding rule (BR). First service conception rate (FSCR) for all dairy cows and heifers was 70% for the control and 54% for the treatment groups (P > 0.05). The FSCR was also not different (P > 0.05) between Holstein (HOL) and Australian Milking Zebu (AMZ) breeds (HOL 52% and AMZ 78%). Moreover, all the animals in this study were confirmed pregnant by the end of the breeding season. In conclusion, dairy cows and heifers can be successfully synchronized using only 125 µg of cloprostenol without impairing fertility. This dose corresponds to only one fourth of the recommended dose of 500 µg of cloprostenol by the manufacturer.

Keywords: prostaglandin, administration, estrus, cattle, lip route.

Efficient and accurate estrus detection is essential to optimize reproductive management of individual cows to yield a profitable dairy operation. Synchronization of estrus through pharmacological control has been used to improve reproductive efficiency and also to decrease the time spent in

detecting animals in estrus (Foote, 1996). Moreover, reproductive management is based on a methodical approach for the entire herd rather than for the individual cow.

PG causes regression of the corpus luteum (CL) of the ovary and subsequent expression of estrus followed

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by ovulation within 2 to 5 d (Foote, 1996). Several field studies have questioned the dosage and interval of the PG administration (Donaldson *et al.*, 1982; Heuwieser *et al.*, 1997; Wright and Malmo, 1992). The rationale behind the choice of ivu route is that PG secreted by the uterus is known to be absorbed by the uterine vein and transferred to the ovarian artery by a countercurrent mechanism resulting in the regression of the CL in the ewe, sow and cow (Pineda, 1989). Understanding of both local and systemic pathways of uterine control of luteal function therefore has physiological and pharmacological implications. Moreover, it has been shown that if PG is infused into the uterus of a cow which has the local countercurrent pathway of uterine control of luteal function, the required dose of PG is about ten times lower than that needed when the parental route is used (Pineda, 1989). Dairy cattle at the Sultan Qaboos University Agricultural Experiment Station (AES) are bred during the cooler months of the year from December through April and subsequently calve from August through December to overcome the adverse effects of heat stress on reproduction during the hotter months of the year (Thatcher and Collier, 1986; Wilson *et al.*, 1998). Observing cows in estrus and breeding them at the optimum time is important for effective reproductive management. For several years at AES, cows were bred based on the traditional way of estrus detection in which herdsmen looked for signs of estrus and then bred them by AI using the am-pm BR. However, during the last breeding season starting in December 1999, estrus was synchronized by the "one and a half" method (Pursley *et al.*, 1997) of PG administration by two routes with two different doses, 500 μg im and 125 μg ivu, and bred by AI to detected estrus using the am-pm BR.

In the "one and a half" method of PG administration, all dairy cows and heifers were first injected with PG and those showing estrus were bred by AI using the am-pm BR. Animals that were not observed in estrus were injected with PG again 11-d later and bred by AI using the same am-pm BR on observed estrus. The advantages of this "one and a half" method of PG administration compared to other synchronization programs are the reduction in cost of both the number of PG administrations used and also the number of services per cow.

The objective of this study was to evaluate the efficiency of estrus synchronization using 125 μg of PG by ivu route compared to 500 μg of PG by im route in dairy cattle.

Materials and Methods

Primiparous and multiparous lactating dairy cows (n=29) and heifers (n=16) of HOL (n=28) and AMZ

(n=17) breeds were randomly assigned to one of two treatments. Estrus was synchronized using the "one and a half" method of PG administration. Control animals received 500 μg of PG analog cloprostenol by im route. Animals in the treatment group received 125 μg of the same PG analog by ivu route. In addition to twice daily observation of estrus in early mornings and late evenings, KAMAR (KAMAR Marketing Group, Inc. Steamboat Springs, Colorado, USA) heat mount detectors were also used as an estrus detection aid. The voluntary waiting period for scheduled breeding was 50-d post-partum in both groups. Cows in each group received the same treatment until diagnosed pregnant or culled from the herd. Pregnancy was confirmed by ultrasound detection of a fetal heartbeat between 30 to 35-d after AI using a 7.5-MHz probe (Aloka 500-ultrasound machine, Corometrics Medical Systems, Wallingford, CT). In addition, daily milk production (MP) was also recorded.

To evaluate treatment and breed differences, Mantel-Haenszel chi-square analysis was used for conception rates (CR) and ANOVA was used for services per conception (S/C), average days open (DO), average lactation number (LN) and average daily MP using the Statistical Analysis System (SAS, 1993).

Results

Eighty two percent of the animals in the control group and 76% of the animals in the treatment group exhibited signs of estrus 2 to 5-d after the first PG administration ($P > 0.05$). The remaining animals in both groups responded to the second PG administration 11-d later.

The first service conception rate (FSCR) for all animals (n=47) was 62% (29/47), control 70% (16/23) and treatment 54% (13/24). The conception rate (CR), increased to 83% (39/47), control 96% (22/23) and treatment 71% (17/24) after the second breeding. The CR after the third breeding was 96% (45/47), control 100% (23/23) and treatment 92% (22/24) and the remaining two animals in the treatment group finally conceived after the fourth breeding.

The FSCR, overall CR, S/C, average DO, average LN and average daily MP for both the treatments and breeds are given in Table 1.

Discussion

The voluntary waiting period in this study was 50-d post-partum as most pharmaceutical companies recommend the use of PG not before 42-d after calving. All the lactating cows responded to the estrus synchronization program indicating that ovarian activity was re-established after calving and the heifers also had a functional CL at the commencement of the breeding

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TABLE 1

The effect of 500 µg by im route (control) and 125 µg by untravulval lip (ivu) route (treatment) of a synthetic prostaglandin F_{2α} analog cloprostenol on first service conception rate (FSCR), overall conception rate (OCR), services per conception (S/C), average days open (DO), average lactation number (LN) and average daily milk production (MP:L/d) for Holstein (HOL) and Australian Milking Zebu (AMZ) cows and heifers.

Treatments	Animals	Breed	FSCR (%)	OCR (%)	S/C	DO ± SEM	LN ± SEM	MP ± SEM
Control	Heifers	AMZ	100 ^a	100 ^a	1 ^a	N/A	0	0
		HOL	60 ^a	100 ^a	1.4 ^a	N/A	0	0
	Cows	AMZ	100 ^a	100 ^a	1 ^a	71.38 ^a ± 7.62	2.88 ^a ± 0.61	13.06 ^a ± 0.52
		HOL	45 ^a	100 ^a	1.67 ^a	86.56 ^a ± 9.71	2.78 ^a ± 0.52	18.84 ^b ± 1.40
Treatment	Heifers	AMZ	67 ^a	100 ^a	1.33 ^a	N/A	0	0
		HOL	80 ^a	100 ^a	1.6 ^a	N/A	0	0
	Cows	AMZ	50 ^a	100 ^a	2 ^a	94.50 ^a ± 11.18	2.50 ^a ± 0.61	12.97 ^a ± 0.51
		HOL	40 ^a	100 ^a	2 ^a	84.11 ^a ± 6.11	2.90 ^a ± 0.51	18.08 ^b ± 1.80
Overall mean ± SEM			62 ± 3.52	100 ± 0	1.50 ± 0.14	84.14 ± 3.39	2.77 ± 0.09	15.74 ± 1.58

N/A- Not Applicable.

^{a,b}Means with different superscripts within columns are significantly different (P < 0.05).

program. This is very important for pharmacological control of estrus cycle to achieve the desired calving interval (Peters and Ball, 1987).

The FSCR for all cows and heifers was 54% in the treatment group compared to 70% in the control group (P > 0.05). However, it is possible to increase the response of the CL to ivu route of PG administration by making sure that the CL is present on the ipsilateral side rather than on the contralateral side of ivu route of PG injection (Pineda, 1989).

It was expected that the FSCR of heifers (71%) would be higher (P > 0.05) than that of lactating cows (58%), as heifers were less subjected to the nutritional demands and stresses associated with lactation (Nobel and McGilliard, 1993). The average daily MP by both breeds corroborate to the earlier findings (Srikandakumar *et al.*, 1996) where the smaller AMZ breed that is more heat tolerant and disease resistant, produces less (P < 0.05) milk than the larger HOL breed at similar lactation numbers.

The CR and S/C (Table 1) in this study were better than the ideal reproductive goals of 60% and 1.65 respectively and the average DO was also within the recommended 90-d to achieve the desired calving interval of one year (Peters and Ball, 1987).

The fact that all the animals conceived by the end of the breeding season in both the control and treatment groups suggests that not only was the estrus synchronization program successful but also that the nutritional and general management of the dairy herd was of a high standard.

Conclusions

Dairy cattle can be successfully synchronized and bred using only 125 µg of the PG analog cloprostenol by ivu route without impairing fertility. This corresponds to only one fourth of the manufacturers

recommended dose of 500 µg of cloprostenol by im route. As a consequence, the reduction in cost associated with estrus synchronization will be an additional benefit to the dairy and beef industry. Moreover, it can be anticipated that this ivu route of PG administration may also benefit other animals that share a similar local countercurrent mechanism of the uterine control of the luteal function such as the pig, sheep and goat.

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