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Comparison of estrus synchronization by controlled internal drug release device (CIDR) and adhesive transdermal progestin patch in postpartum beef cows

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ABSTRACT

Estrous synchronization with progesterone based protocols has been essentially used in cattle industry. Although intravaginal devices have been commonly used, this technique may induce vaginitis. This study aimed at examining the efficiency of novel transdermal progestin patch on follicle development and comparing the progestin patch versus CIDR device on estrous synchronization, complication at treated site and pregnancy in beef cattle.

In experiment 1, seven beef cows were treated with an adhesive transdermal progestin patch on the ventral surface of the proximal part of the tail for 7 days. The cows were daily examined the follicular development using ultrasonography starting on Day 0 till 3 days after hormone removal. Experiment 2, forty beef cows were divided into two equal groups (20 cows per group). The cows randomly allocated to received either vaginal insertion of CIDR (n = 20) or treated with an adhesive transdermal progestin patch (n = 20). The levels of plasma progesterone during the experiment and the numbers of standing estrous cows were recorded. Timed artificial inseminated (TAI) was performed at 60 h after CIDR or patch termination. Pregnancy rates were determined at 60 days after TAI. Experiment 1 revealed that the novel transdermal progestin patch could efficiently control follicular growth. All the seven treated cows had dominant follicle upon dermal patch removal indicating the effectiveness of the progestin patch. In experiment 2, the percentages of cows exhibited standing estrus were similar between transdermal patch (72.22%) and CIDR (70.00%). The levels of plasma progesterone during CIDR treatment were significantly higher (4.06 ± 1.65 ng/mL on Day 1 and 3.62 ± 1.60 ng/mL on Day 7) compared with transdermal patch (2.60 ± 1.43 ng/mL on Day 1 and 1.81 ± 1.57 ng/mL on Day 7). Three cows treated with CIDR (15%) developed vaginitis while none of cows had physically dermal reaction at adhesive site. Cows synchronized with these two protocols had similar pregnancy rates (50.00%) following fixed time artificial insemination. It is concluded that transdermal progestin patch was equally effective in estrus synchronization as compared with traditional CIDR. However, the transdermal patch demonstrated less complication. This device should therefore be considered as an alternative method for estrus synchronization in postpartum beef cattle.

1. Introduction

It is widely known that the efficiency of artificial insemination (AI) in beef cattle is closely related to the success of estrus detection. Low conception rates in cattle after AI caused by mistakes in estrus detection are often found on beef cattle farms because beef cattle have a short estrus period and present unclear estrus behavior [1]. An enhanced method to improve the efficiency of AI and reduce mistakes in estrus detection in cyclic beef cattle is estrus synchronization. The goal of estrus synchronization is to control

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follicular development and corpus luteum (CL) function so that ovulation time is controlled more precisely to allow a single timed artificial insemination (TAI) without the need for of estrus detection [2]. Methods for hormonal estrus synchronization in beef cattle such as the type of hormone used and the timing and form of hormonal administration have been extensively studied. Estrus synchronization in beef cattle has been successfully achieved by the use of prostaglandin, progesterone, progesterone with estrogen or prostaglandin combinations, gonadotropin with prostaglandin combinations, and gonadotropin with prostaglandin and progesterone combinations [3].

A recent generally available and successful estrus synchronization protocol for beef cow is a combination of the hormone progesterone in the form of a controlled internal drug release (CIDR) device along with $PGF_{2\alpha}$ because it is effective in inducing estrus in suckling beef cows sooner after calving and in replacement heifers at a younger age. In additional, the CIDR can achieve almost 50% synchronization in non-cycling cows to express clear estrus signs after CIDR withdrawal [4,5]. Treatment with an exogenous intravaginal impregnated CIDR for 7–12 days can induce a negative feedback in the hypothalamus and pituitary and inhibit the release of gonadotropin hormone [6]. After CIDR removal, larger quantities of gonadotropin are released to stimulate development of follicles, release the hormone estradiol, resume estrus and synchronize ovulation or to luteinize large dominant follicles [7]. The $PGF_{2\alpha}$ administration at the time of CIDR withdrawal can regress the functional corpus luteum (CL), reduce progesterone concentration levels and successfully induce the growth of follicles and estrus [8,9]. It is known as well that CIDRs have been used with good results in several countries for many years. The T-shaped CIDR device is inserted intravaginally with an applicator and releases progesterone, which is absorbed into the blood circulation quickly [10]. On the end opposite the CIDR wing there is an attached tail which hangs outside the animal making it possible to easily remove the inserted device after treatment [10]. Thus, estrus synchronization with the CIDR is simpler than other progesterone techniques such as the ear implantation method.

On other hand, even though CIDR is effective in inducing estrus and is also easier to use in cattle, it can cause irritation to the vaginal epithelium, and there may be a clear, cloudy, yellow or bloody mucus discharge on the outside of the CIDR device when removed [11]. Moreover, the CIDR may cause vaginal and uterine infection, and pyogenic bacteria are found in the vagina and uterus on Day 7 and the day of AI after intravaginal CIDR insertion. The protruding tail of the CIDR may cause severe infection [12]. Thus, it would be beneficial to have an alternative noninvasive method that is effective for estrus synchronization, easy to use, and painless to the animal and causes no complications in the reproductive tract of beef cattle.

Presently, the transdermal combination hormonal contraceptive patch has come into use in women. It contains progestin norelgestromin and the estrogen ethinyl estradiol and is called Evra® or Ortho Evra® [13]. A single patch of 20 cm^2 size provides sufficient hormones. It delivers a daily dose of 150 μg norelgestromin and 20 μg ethinyl estradiol for 7 days while worn and is enough to inhibit of ovulation for 9 days in women [13]. The hypothesis of the present study is that it is possible to use a progestin hormone impregnated as adhesive transdermal patch along with $PGF_{2\alpha}$ administration as a protocol for estrus synchronization in beef cows. The expected results are that this protocol will be able to induce estrus as well as the estrus synchronization with CIDR with $PGF_{2\alpha}$ treatment protocol and it will cause no irritation or bacterial infection in the vagina and uterus of the cow.

The objectives of this study were to (1) approve the ability of progestin based transdermal patch on follicular growth and (2) compare efficacy of CIDR device and transdermal progestin patch based protocols for estrous synchronization, complication at treated area and pregnancy rate in beef cattle.

2. Materials and methods

The experiment was approved by the Animal Ethics Committee of Faculty of Veterinary Medicine, Mahanakorn University of Technology (MUT), Bangkok, Thailand.

2.1. Experimental designs

Seven cows (Experiment 1) were treated with adhesive transdermal progestin patches (6.0 mg norelgestromin and 0.75 mg ethinyl estradiol; Ortho Evra®, Ortho-McNeil Pharmaceuticals, Raritan, New Jersey, USA) for 7 days, on the skin at the ventral side of the proximal part of tail. The adhesive area was chosen because it was easy to paste, less hairs and the skin is soft and thin. These properties of the skin appear to promote hormone absorption into blood circulation. The patch was covered with adhesive tape to protect it from the urine and feces of the animal during treatment. Immediately after patch removal, each cow was given an intramuscular injection of $PGF_{2\alpha}$ (25 mg dinoprost tromethamine; Lutalyse®, Pfizer Animal Health, New York, USA). Follicular development was daily observed from both sides of the ovaries since Day 0 (a day before patch adhesion) till Day 10 (3 days after patch removals) using transrectal ultrasonography. All follicles (approximately 2–3 mm in diameter) were mapped on ultrasonography. The maximal diameters of the largest or expected dominant follicles were daily recorded. The presence of dominant follicle (larger than 10 mm) was examined on day 3 after progestagen withdrawal.

Forty cows (Experiment 2) were randomly assigned into two equal groups. The twenty cows (Group 1) were treated with impregnated intravaginal controlled internal drug release (CIDR) devices (1.9 g progesterone CIDR®; Eazi-Breed®, Pfizer Animal Health, Hamilton, New Zealand) for 7 days, followed by intramuscular treatment with $PGF_{2\alpha}$ (25 mg dinoprost tromethamine; Lutalyse®) at the time of CIDR withdrawal. The remaining twenty cows (Group 2) were treated with adhesive transdermal progestin patches and $PGF_{2\alpha}$ as similar as described in the experiment 1 (Fig. 1).

2.2. The experimental animals

Experiment 1 was conducted with the outdoor temperatures ranging from 28 to 40 °C and an average relative humidity of 77.35%. Seven postpartum (about 3–4 months after calving) pluriparous Brahman-Thai native beef cows were chosen from farm of Faculty of Veterinary Medicine, MUT. Their ages ranged from 3 to 6 years old and ranged of parity were 1–3. Their average body weight was 380.00 ± 96.26 kg (mean ± SD) and their body condition score was about 2.5 out of 5 according to the scale of Edmonson et al. [14].

Experiment 2 was performed during summer season with the outdoor temperatures ranging from 25 to 38 °C and an average relative humidity of 70.58%. Forty postpartum (about 2–4 months after calving) pluriparous Brahman beef cows were randomly selected from the herd of the Lamphayaklang Livestock Research and Breeding Center, Department of Livestock Development, Lopburi, Thailand. Their ages ranged from 4 to 8 years old and ranged of parity were 2–5. Their average body weight was 438.90 ± 46.55 kg (mean ± SD) and their body condition score was about 3 out of 5 according to the scale of Edmonson et al. [14].

All cows in experiment 1 and experiment 2 had completed uterine involution and were healthy, cycling normally and free from any anatomical or reproductive disorders. A short period before the