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Onset of luteolytic action of exogenous prostaglandinF-2α during estrous cycle in goats

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ABSTRACT

The objectives of these two experiments were to determine the day of onset of luteolysis after exogenous PGF-2α administration during the estrous cycle and the fertility of this synchronized estrus in goats. In the first experiment, during the breeding season, 48 Nubian does were estrous synchronized, using intravaginal sponges impregnated with a progestin, and estrus was detected by vasectomized bucks. The does were divided at random into three groups of 16 does each to be treated at days 2, 3, and 4 of the estrous cycle (estrus = day 0). Then, at each day of injection, the does were again randomly divided to receive a single dose of natural prostaglandin F-2α im (PGF-2α; 5 mg/doe; treatment [TRE] group) or sterile saline solution (control [CON] group; 1 mL/doe). Finally, the following groups were originated: TRE-2, CON-2, TRE-3, CON-3, TRE-4, and CON-4. The overall estrus response after treatment with PGF-2α (TRE group, 70.8%) was higher than saline (CON group, 12.5%, $P \leq 0.001$). Estrus response for TRE-2, CON-2, TRE-3, CON-3, TRE-4, and CON-4 was 25% (2 of 8), 12.5% (1 of 8), 87.5% (7 of 8), 12.5% (1 of 8), 100% (8 of 8), and 0% (0 of 8) for the same groups, respectively. Estrus response was different between day 2 and days 3 and 4 ($P \leq 0.04$) and not between day 3 and day 4 ($P \geq 0.05$). In the second experiment, 15 multiparous Boer does were estrous synchronized with control internal drug release (CIDR, 300 mg progesterone = P_4) and PGF-2_α and randomly divided to receive one single dose of PGF-2α im at days 2, 3 or 4, after synchronized estrus (n = 5 at each day). The does were detected twice a day for estrus, and blood was collected daily for P_4 determination for 11 days after the synchronized estrus. Each doe in estrus was bred by hand mating to a proven male. All the does with a functional corpus/corpora luteum/lutea (CL; ≥1.0 ng/mL of P_4) responded to PGF-2α with a drop in P_4 levels that either lasted only 24 h for the does that did not show estrus (0.27 ± 0.10 ng/mL; n = 4) or persisted longer in all the does that showed estrus (0.22 ± 0.18 ng/mL; n = 10; P = 0.47). Estrus response for days 2, 3, and 4 was 20% (1 of 5), 80% (4 of 5), and 100% (5 of 5), respectively (P = 0.05). The conception rate was 100%, 100%, and 80% for the same days of administration, respectively (P = 0.64). It was concluded that luteolytic action of PGF-2α begins at day 3 of the estrous cycle by inducing an ovulatory and fertile estrus in goats.

1. Introduction

The benefits of using highly qualified bucks by hand mating or artificial insemination have increased interest in controlling the time of estrus in goats [1,2]. During the breeding season, two types of drugs are frequently used for synchronized estrus in does: luteolytics [3–7], progestins [8], or a combination [9]. In goats, luteolytic agents such as PGF-2α and their analogues induce the lysis of the corpus luteum between the fourth and the sixteenth day of the estrous cycle [3,10] and consequently are only effective during the breeding season [11]. In a previous report, three does from one program of estrous synchronization received natural PGF-2α on day 3 after the end of estrus (day 0), and all showed estrus at a mean of 56 h after injection [6]. However, in this observational study, it was not possible determine if this estrus was due to the luteolytic effect of PGF-2α or the females had a natural short estrous cycle. In addition, information about the fertility of this estrus was not performed or clearly established in other reports [3,6,10]. If PGF-2α is luteolytic at this early stage of the estrous cycle, it could not only lengthen the days in which PGF-2α during the estrous

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cycle could be administered but also, enhance our knowledge about goat reproduction. Therefore, it was considered necessary to reinvestigate when the luteolytic action of PGF-2α during estrous cycle and its fertility begin.

The objective of the present experiments was to evaluate the initiation of luteolytic effect of natural PGF-2α during the estrous cycle, as well as its fertility.

2. Material and methods

2.1. First experiment

This experiment was carried out in a farm, in Montevideo, the southern part of Uruguay, during March under natural lighting conditions (fall season in the southern hemisphere). The animals were 48 pluriparous nonlactating Nubian does selected at random from one herd of 80. The does mean age was (±SD) 2.8 ± 0.9 (range 2–6), and mean body condition score was 2.9 ± 0.3 (2.5–3.5). The weight was between 40 and 55 kg. The body condition score was evaluated at the time of sponge removal [12]. Each doe was submitted before the assay to a general physical examination and vaginal inspection. At this time, the does were orally dewormed with Levamisol (Tetramit "L" oral, Laboratorio Dispert, Montevideo, Uruguay) at a dose of 15 mg/kg. All goats were grazed on improved pasture from 0830 to 1800 h and were fed 400 g per head per day of balanced concentrate in their stalls. Mineral salt and water were offered ad libitum. The does were divided at random into three groups of 16 does each to be treated at days 2, 3, and 4 of the estrous cycle (estrus = day 0). Then, at each day of injection, the does were again randomly divided to receive a single dose of natural prostaglandin F-2α (PGF-2α; 5 mg/doe; TRE group; Lutalyse, The Upjohn Co. Kalamazoo, Michigan) or sterile saline solution (CON group; 1 mL/doe), both administered. Finally, the following groups were constituted: TRE-2, CON-2, TRE-3, CON-3, TRE-4, and CON-4. Estrus was synchronized using fluorgestone acetate (FGA, 30 mg; Chronogest, Intervet International B.V. Boxmeer, Holland) intravaginal pessaries over 14-day period. To avoid having all females in estrus on the same day, the does were divided in half and synchronized 2 weeks apart, thus permitting the reasonable use of the teaser. Estrus was detected by utilization of 2-year-old vasectomized buck led by hand and during 5 days after pessary removal at 8-h intervals (at 0600, 1400 and 2200 h). The does were considered to be in estrus when they stood to be serviced by the teaser. After the end of estrus, the does were estrus detected twice a day (at 0600 and 1800 h) and received PGF-2α according to scheme mentioned previously. Estrus onset was defined as the time elapsed between pessary removal and the mean time between the last rejection and first accepted mount. Estrus response was defined as the number of does in estrus from the total number of does estrous synchronized.

2.2. Second experiment

All procedures used in this experiment were in compliance with the Guide for the Care and Use of Agriculture Animals in Research and Teaching, and were approved by the Texas A&M University Institutional Animal Care and Use Committee. The Teaching and Research Goat herd from Large Animal Clinical Sciences was used. Fifteen Boer does were randomly selected from a herd of 30 does. The mean age of the females was 3.7 ± 0.3 years (3.5–4.0), mean weight was 65.5 ± 13.1 kg. (50–100), and mean body condition score was 3.3 ± 0.4 (2.5–3.75). The weight and body condition score were evaluated at the time of CIDR removal [12]. Does were housed in a barn in groups of no more than four does per pen with free coastal hay available and supplemented with a commercial mixed concentrate ration formulated for maintenance does (minimum guarantees: 16% crude protein, 3.0% crude fat, 16% crude fiber, 0.9% Ca, 0.55% P) and fed individually twice daily with 450 g per doe per meal. All does had free access to water and trace mineral salt. During the fall season, the Boer does were estrous synchronized with CIDR (P_4 300 mg) maintained in the vagina for 7 days and received 50 μg of GnRH im at device insertion and 5 mg of natural PGF-2α at device removal. After CIDR removal, the does were estrus detected by using a vasectomized teaser. Each female in estrus was permitted to be serviced by the teaser. Does were randomly divided to receive one single dose of PGF-2α at days 2, 3, or 4 of estrous cycle (n = 5 at each day) and were detected twice a day for estrus; blood was collected daily for P_4 determination for 11 days after this synchronized estrus. Blood was collected once a day in the morning between 8 a.m. and 10 a.m. in chilled vacuum tubes with lithium heparin (10 mL) maintained in a cooler at 4–5 °C. Then, the blood was centrifuged in the next 4 h, and the plasma was saved at - 80 °C for further analysis. All plasma samples were assayed for P_4, using a solid-phase radioimmunoassay kit containing antibody-coated tubes and ^{125}I-labeled P_4 (Coat-A-Count P4, Siemens Medical Solutions Diagnostics, Los Angeles, California). All the samples were analyzed in duplicate in a single assay, and the intra-assay coefficient of variation and sensitivity were 4.5% and 0.1 ng/mL, respectively. A doe was considered to have a functional corpus luteum when P_4 was at least 1.0 ng/mL [5]. Each female that showed estrus after PGF-2α was bred to one proven male by hand mating system every 12 h to the end of estrus. Two proven bucks that had been previously evaluated according to the criteria of the Society for Theriogenology for breeding soundness were used [13]. The diagnosis of pregnancy was performed between days 24–25 after estrus by using transrectal ultrasonography by using a 7.5 MHz linear prostatic probe (Aloka 500 SSD, Corometrics Medical Systems Inc., Wallingford, CT, USA) as previously reported [14]. The same definitions as experiment 1 were used. Copulation was defined as penile intromission into the vagina with thrusting. The conception rate was the percentage between animals pregnant and does that were mated.

2.3. Statistical analysis

Estrus response was analyzed by X^2 analysis with Yates correction or Fisher Exact Test as appropriate. The level of P_4 prior to and after administration of PGF-2α was analyzed by student "t" test for paired samples. The comparison between levels of P_4 among days of treatments was compared by analysis of variance. All data were expressed as mean plus or minus 1 standard deviation (SD) except for the graphic that standard error was used. Differences were considered significant at $P < 0.05$ [15]. Statistical software was used to perform all statistical analyses [16].

3. Results

3.1. Experiment 1

The results are shown in Table 1. No does lost their intravaginal pessaries, and all showed estrus after synchronization. Estrus response from all the does from days 2–4 after treatment with PGF-2α (TRE group; 70.8%) was higher than saline (CON group; 8.3%; $P \leq 0.001$). Estrus response for TRE-2, CON-2, TRE-3, CON-3, TRE-4, and CON-4 was 25% (2 of 8), 12.5% (1 of 8), 87.5% (7 of 8), 12.5% (1 of 8), 100% (8 of 8), and 0% (0 of 8) for the same groups, respectively. Estrus onset for the same groups was (mean ± SD) 48.0 ± 0; 60.0 ± 0; 51.4 ± 12.4; 48.0 ± 0; 57.0 ± 16.6; and 0 h, respectively. Estrus response was different among days for TRE group. Differences were detected between day 2 and days 3 and 4 ($P \leq 0.04$) but not between day 3 and day 4 ($P \geq 0.05$).