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Short communication

Long-day photoperiod exposure in lactating goats to induce post-partum ovulatory activity

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ABSTRACT

In the present study, the continuous application of an artificial long-day photoperiod to induce a refractory state affecting the recovery of post-partum ovulatory activity in subtropical Creole does kidding in autumn, was investigated. For this purpose, a group of does was kept under a natural photoperiod from parturition up to 158 days of lactation (control group: $n = 16$). The other group was subjected to an artificial long-day photoperiod (16 h light:8 h darkness; treated group: $n = 16$) from day 10 to 158 of lactation. For the first 96 days postpartum, all does from both the control and treatment groups did not show ovulation. However, from day 108 to 156 post-partum, the proportion of does that exhibited ovulation was greater ($P < 0.01$) in the treated group (11/16; 69%), than in the control group (2/16; 12.5%). In addition, the does in the treated group produced 15% more milk on average than the does in the control group at 60 and 90 days of lactation ($P < 0.001$). The body weight and body condition were not affected by the photoperiod treatment ($P > 0.05$). It could be concluded that, for subtropical lactating does that gave birth in autumn, continuous exposure to an artificial long-day photoperiod induces post-partum ovulatory activity after 150 days of exposure. This behaviour is probably attributable to the induction of a refractory state of the ovary, following continuous exposure to the artificial long days. Furthermore, this photoperiod treatment also increased the milk production level in goats at 60 and 90 days of lactation.

1. Introduction

The post-partum anovulation period (AVPP) is generally defined as the stage between parturition and the first post-partum ovulation. In sheep and goat breeds that display reproductive seasonality, this AVPP depends on the season of kidding. Thus, in the Creole doe from subtropical México, the duration of the AVPP is longer in females that kid in January (±200 days), than those that kid in May (±100 days) or October (±50 days) (Delgadillo et al., 1998). In this breed, the annual reproductive activity of female goats is regulated by the photoperiod (Delgadillo et al., 2011).

Indeed, under artificial conditions, short days stimulate ovarian activity, while long days inhibit it (Duarte et al., 2010). However, when non-lactating females are continuously exposed to artificial long days, ovulatory or endocrine activities start between 150 and 200 days after the onset of the long-day signal (Maeda et al., 1988). This phenomenon occurs because the animals became insensitive to the continuous perception of short or long photoperiods.

A long-day photoperiod may also modify the level of milk production in ruminants. So for instance, in ewes and goats from temperate and subtropical latitudes, exposure to an artificial long-day photoperiod may increase milk

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production by 25% and 18%, respectively (Bocquier et al., 1997; Flores et al., 2011). However, in lactating females exposed to artificial long-day treatments during the first 75 days of lactation, a complete inhibition in post-partum ovulatory activity is induced (Bocquier et al., 1993; Hernández et al., 2006). One possible explanation for this phenomenon could be that the long-day photoperiod inhibits the recovery of ovulatory activity, as observed for non-lactating goats (Duarte et al., 2010). Another explanation may be that lactating goats require exposure to a photoperiod of more than 75 days to express refractoriness to long days and thus initiate post-partum ovulatory activity. There may also be an interaction between lactation and long-day photoperiod treatment. Indeed, long days increase milk production, which in turn could inhibit the recovery of post-partum ovulatory activity. Therefore, in the present study, continuous exposure to an artificial long-day photoperiod in goats kidding during autumn to induce a refractory state was investigated – in affecting the recovery of post-partum ovulatory activity.

2. Materials and methods

The present study was conducted in the Region of Laguna, in the state of Coahuila, Mexico (latitude, 26°23′N; longitude, 104°47′W). In this region, the photoperiod varies from 10 h 19 min of light in mid-winter to 13 h 41 min during the summer solstice.

Thirty-two Creole pregnant female goats obtained from a commercial flock of 100 animals were used in the experiment. The mean date of kidding (±SEM) for all goats was 8th November ± 2 days, and the prolificacy (mean number of kids/female kidding) was 1.8 ± 0.1. Goats were fed 4.0 kg of sorghum silage/goat daily (as fed; 2.17 Mcal ME/kg DM; 9.4% CP) and 1.0 kg/goat of a commercial concentrate containing 14% CP. Goats had free access to water and mineral salts, which were provided in 25 kg blocks (Cebú, Salinas del Rey, Torreón, México) and contained at least 17% P, 3% Mg, 5% Ca, and 75% NaCl. During the first 9 days post-partum, all females and their kids were maintained under natural photoperiod. Then, from day 10 post-partum, does were divided into 2 homogeneous groups, according to their initial milk production (Fig. 2) and initial body condition score (BCS; Fig. 3). Does in the control group ($n = 16$) were kept under a natural photoperiod for up to 158 days post-partum. Does in the treatment group (n = 16) were exposed to an artificial long day photoperiod (16 h light:8 h darkness) from 10 to 158 days post-partum. In both groups, kids were weaned 28 days post-partum, and all goats were milked manually twice daily (07h00 and 19h00). To provide a photoperiod of long days to the light-treated group, the open shaded pen was equipped with daylight-type lamps (Philips, Koninklijke, Netherlands) that emitted a minimum light intensity of 400 lux, when measured at the eye level of the goats. Lights were turned on from 06h00 to 09h00 and again from 17h00 to 22h00, to extend the duration of natural day-length and obtain a total of 16 h light/day.

In both treatment groups, post-partum ovarian activity was recorded at day 12 post-partum, and thereafter every 12 days, up to day 156 post-partum. Transrectal ultrasonography was used to record the post-partum ovarian activity (Ginther and Kot, 1994). A goat was considered to have initiated post-partum ovulatory activity when at least 1 corpus luteum was observed on one of the ovaries.

Milk production was measured on days 7, 30, 60, 90, 120, and 150 of lactation. During the first 2 measurements, milk production was assessed using the method of weigh-suckle-weigh over a 24-h period. Subsequently, milk production was measured by means of hand-milking, twice daily combined with an intravenous oxitocin injection, to extract the residual milk. Body weight (BW) and BCS of all females were determined every 2 weeks, up to 158 days post-partum. Does were weighed and BCS was determined by palpating the spinous region and the musculature of the lumbar region of the spine.

The cumulative percentage of does that exhibited ovulation was compared using the two-sample Kolmogorov–Smirnov test. Milk production, BW, and BCS were analysed using a two-way analysis of variance (time and group within- and between-factors, respectively), with repeated measurements. The milk production, BW, and BCS data are presented as the mean ± SEM. The results were considered significant at a confidence level of $P \leq 0.05$. Analyses were computed using the statistical package SYSTAT 13. The procedures used in the experiments reported here were in accordance with the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 2010).

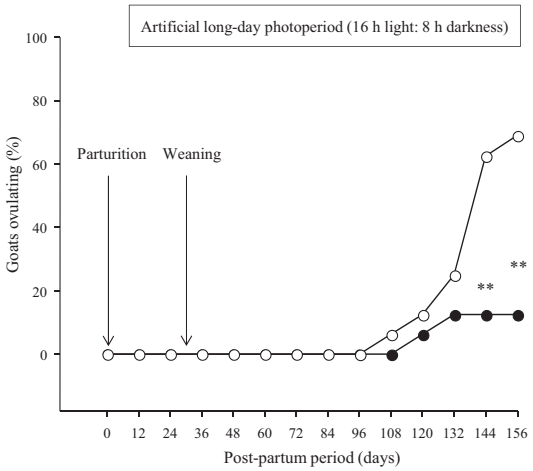

Fig. 1. Percentage lactating goats ovulating during the first 156 days post-partum (control; $n = 16$, ●; treated; $n = 16$, ○) (significant differences indicated – $^{**}P < 0.01$).

3. Results

During the first 96 days postpartum, none of the does from either the control or treated group ovulated. However, from day 108 to day 156 post-partum, more does ovulated in the treated group than in the control group ($P < 0.01$; Fig. 1). The mean daily milk production obtained during the first 30 days of lactation did not differ between the groups ($P > 0.05$; Fig. 2). However, after the kids had been weaned, an effect of photoperiod ($P < 0.001$) and time of the study

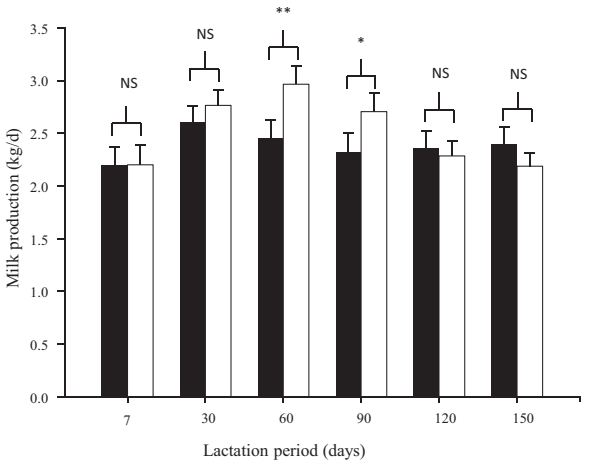

Fig. 2. Mean (±SEM) daily milk production of does maintained under a natural photoperiod (control; $n = 16$, ●) or submitted to an artificial long-day photoperiod (treated; $n = 16$, ○) (significant differences indicated – $^{*}P < 0.05$ and $^{**}P < 0.01$).