Domestic Animal Endocrinology 48 (2014) 119–125

Contents lists available at ScienceDirect

Domestic Animal Endocrinology

journal homepage: www.domesticanimalendo.com

Reducing exposure to long days from 75 to 30 days of extra-light treatment does not decrease the capacity of male goats to stimulate ovulatory activity in seasonally anovulatory females

J.L. Ponce [a], H. Velázquez [a], G. Duarte [a], M. Bedos [a], H. Hernández [a], M. Keller [b], P. Chemineau [b], J.A. Delgadillo [a,*]

[a] Centro de Investigación en Reproducción Caprina, Universidad Autónoma Agraria Antonio Narro, Periférico Raúl López Sánchez y Carretera a Santa Fe, Torreón, Coahuila, México
[b] Physiologie de la Reproduction et des Comportements, UMR 7247 INRA-CNRS Université de Tours-37380, Nouzilly, France

ARTICLE INFO

Article history:
Received 30 October 2013
Received in revised form 11 March 2014
Accepted 12 March 2014

Keywords:
Caprine
Male effect
Photoperiod
Testosterone secretion
Ovulation
Sexual behavior

ABSTRACT

The response of male goats exposed to different durations of long days (LD) during an extra-light treatment in autumn-winter, and their ability to induce ovulations in seasonally anovulatory goats were investigated in 2 experiments. In experiment 1, control males were exposed to natural photoperiod (n = 5), whereas 4 additional groups (n = 5/group) were exposed to 16 h of light per d during 75, 45, 30, or 15 d of LD. In the 4 groups, photoperiodic treatments ended on January 15th. Plasma concentrations of testosterone were determined in blood samples obtained once a week from October 15th to May 30th. The rise of testosterone levels occurred earlier in males from the 75-LD and 45-LD groups than in those from the 30-LD, 15-LD, and control groups ($P < 0.05$). In addition, the time during which levels of testosterone remained >5 ng/mL was longer in males from the 75-LD and 45-LD than in those from the 30-LD and 15-LD groups ($P < 0.05$). In experiment 2, a group of anovulatory goats (n = 13) was isolated from males, while 3 additional groups were put in contact during 15 d with males previously exposed to 75, 45, or 30 days of LD (n = 25, 27, and 26 females/group, respectively and n = 3 males per group). The proportion of goats that ovulated was higher in the 3 groups in contact with the photo-stimulated males (range: 88%–92%) than in the group isolated from them (0%; $P < 0.05$). The proportion of pregnant females did not differ between the 3 groups of does in contact with photo-stimulated males (range: 78%–92%; $P > 0.05$). We conclude that, in our experimental conditions, a photoperiodic treatment as short as 30 d of LD during autumn-winter, stimulated testosterone secretion of bucks during their period of sexual rest and rendered them able to induce ovulations in seasonal anestrous goats and to obtain pregnancies in these females.

1. Introduction

The reproductive seasonality showed by breeds of goats from temperate and subtropical latitudes constitutes an important limitation for inducing reproduction during the season of sexual rest [1–4]. To solve these limitations associated with reproductive seasonality, socio-sexual relationships have been used to stimulate the sexual activity of seasonal breeds of goats during the nonbreeding season [5–7]. Thus, the introduction of a male into a group of seasonally anestrous does or ewes, stimulates and synchronizes LH secretion, ovulations, and estrous behavior

* Corresponding author. Tel.: +52 (871) 729 76 42; fax: +52 (871) 729 76 50.
E-mail address: joaldesa@yahoo.com (J.A. Delgadillo).

0739-7240/$ – see front matter
http://dx.doi.org/10.1016/j.domaniend.2014.03.002

[8–10]. This technique of sexual biostimulation is known as the "male effect" [11–13].

The proportion of females ovulating or displaying estrous behavior after the male effect varies according to the intensity of the sexual behavior of males [14,15]. Indeed, in the northern hemisphere, bucks rendered sexually active by exposure to 75 d of long days (LD) from November 1st followed by natural photoperiod, induce ovulations in most of seasonally anovulatory females, whereas untreated bucks are unable to do so [16,17]. The capacity of the photo-stimulated males to induce the ovulatory activity in anestrous females is likely because of the fact that the 75 d of LD stimulates testosterone secretion, sexual behavior, odor, and male vocalizations from February to April, these months corresponding to the nonbreeding season in the northern hemisphere [17–19].

In rams kept in a lightproof building, a period of 30 d of LD followed by 120 d of short days (SD) stimulated testosterone secretion and increased scrotal circumference [20]. Moreover, bucks and rams exposed to alternate long and short day-light regimens of 30-d duration fail to exhibit endocrine and reproductive changes expected for males exposed to natural photoperiod [21–23]. In Alpine bucks exposed to the previously described light regime, testosterone secretion increased during LD and decreased during SD because of the rapid alternations of day length [23]. All these results suggest that in bucks and rams, 30 d of LD are long enough to sensitize the males and allowing them to be responsive to the following 30 artificial days of SD. However, the minimal duration of artificial LD necessary to induce the sexual activity of bucks during the natural sexual rest when kept under natural photoperiodic conditions is not known, and this is also the case regarding the capacity of these photoperiodic treated males to stimulate the ovulatory activity in seasonally anestrous goats. Thus, we performed 2 experiments: in the first one, we compared testosterone secretion in bucks exposed to 15, 30, 45, and 75 d of LD and hypothesized that 15 d of LD would be able to stimulate testosterone secretion. Then, in a second experiment, we compared the response to the male effect in seasonally anovulatory goats exposed to males submitted to 30, 45, and 75 d of LD.

2. Materials and methods

2.1. General management conditions

We performed 2 experiments during 2 consecutive years using local Mexican goats (*Capra hircus*) from the Laguna region in the State of Coahuila, Mexico (latitude, 26°23′ N and longitude, 104°47′ W). In these females isolated from males, the anestrous period lasts from February-March to August-September, while in bucks isolated from females, the sexual rest lasts from January-February to May-June [3,4]. In the present experiments, animals were fed 2 kg of alfalfa hay (18% CP) and 200 g/d of commercial concentrate (14% CP; 1.7 Mcal/kg) per animal, with free access to mineral blocks and water during the study.

Experimental procedures used in both experiments were in accordance with the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching [24].

2.2. Experiment 1

The objective of experiment 1 was to determine whether durations of LD treatments as short as 15 d could stimulate the testosterone secretion of bucks during the nonbreeding season.

2.2.1. Photoperiodic treatments

Male goats were 1-yr-old at the beginning of the study. On October 1st, males were divided into 5 groups (n = 5/group) balanced for scrotal circumference (Table 1). Bucks from each group remained into a shaded outdoor pen (5 × 5 m) until the end of the study on May 30th. Control males were exposed to the natural photoperiodic conditions (13 h 41 min of light at the summer solstice and 10 h 19 min of light at the winter solstice) throughout the study. Males from the other 4 groups were submitted to different periods of LD, all ending on January 15th (Fig. 1). Long days

Table 1
Characteristics of testosterone secretion in local male goats from subtropical Mexico (26°N). Control males were exposed to natural photoperiodic conditions (n = 5). The other 4 groups were exposed to artificial long days (LD; 16 h of light per d) during 15 (15-LD), 30 (30-LD), 45 (45-LD), and 75 (75-LD) consecutive days. The onset of photoperiodic treatments differed between groups but all of them ended on January 15th.

Groups	n	First increase in plasma testosterone >5 ng/mL	First decrease in plasma testosterone <5 ng/mL	Duration of high plasma testosterone >5 ng/mL (d)	Interval between end of LD and first increase in plasma testosterone >5 ng/mL (d)	Scrotal circumference (cm)
Control	5	May 16 ± 4[a]	—	—	—	22 ± 0.3[a]
15-LD	5	March 28 ± 5[b]	April 26 ± 2[a]	29 ± 3[a]	72 ± 5[a]	23 ± 0.4[a]
30-LD	5	March 20 ± 3[b]	April 17 ± 2[a,b]	28 ± 3[a]	64 ± 3[a]	23 ± 0.2[a]
45-LD	5	February 17 ± 1[c]	April 7 ± 3[b]	49 ± 4[b]	33 ± 1[b]	24 ± 0.6[a]
75-LD	5	February 14 ± 4[c]	April 23 ± 4[a]	69 ± 6[c]	30 ± 4[b]	23 ± 0.3[a]

Abbreviation: SEM, standard error of the mean.
Results are expressed as mean ± SEM.
[a,b,c] Values with different letters within each column differ significantly ($P < 0.05$).