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Switching photo-stimulated males between groups of goats does not improve the reproductive response during the male effect

J. Loya-Carrera[a], M. Bedos[a], J.L. Ponce-Covarrubias[a], H. Hernández[a], P. Chemineau[b], M. Keller[b], J.A. Delgadillo[a,*]

[a] Centro de Investigación en Reproducción Caprina, Universidad Autónoma Agraria Antonio Narro, Torreón, Coahuila, Mexico
[b] Physiologie de la Reproduction et des Comportements, UMR 7247 INRA-CNRS-Université de Tours, 37380 Nouzilly, France

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ABSTRACT

We aimed to determine whether the daily exchange of photo-stimulated males among subgroups of females improved the reproductive response of anestrous goats exposed to males. Bucks were rendered sexually active during the rest season by exposure to 2.5 months of long days from November 1st. In April, males ($n = 3$) were put in contact with three subgroups of anestrous goats (one male per 12 females) where they remained throughout the study, constituting the fixed-group. Other males ($n = 3$) were put in contact with three subgroups of females (one male per 11–12 females) and were rotated daily among them, constituting the rotated-group. The sexual behavior of all males was registered from 08:00 to 09:00 on days 0, 1, 2, and 8 after exchanging the males from the subgroups of females. Ovulation and pregnancy rates were determined by transrectal ultrasonography. The occurrences of ano-genital sniffing, nudging (days 1, 2, and 8), and mounting attempts (days 2 and 8) were greater in the rotated than in the fixed-group ($P < 0.01$). The proportions of females that ovulated did not differ among goats from the fixed (92%) and rotated-group (94%; $P > 0.05$). The proportion of pregnant females and the fertility at kidding did not differ between those from the rotated (79% and 59%) and fixed-group (83% and 61%; $P > 0.05$). We conclude that the daily exchange of photo-stimulated males among subgroups induced an increase of their sexual behavior, but does not improve the pregnancy rates in seasonal anestrous goats.

1. Introduction

Reproductive seasonality is a common characteristic in some goat breeds originating from or adapted to the subtropical latitudes. In females from these subtropical breeds raised in the northern hemisphere, an anovulatory period occurs from February–March to August–September (Duarte et al., 2008; Lassoued and Rekik, 2005). Males of these subtropical breeds also showed a sexual rest season from December–January to May–June (Delgadillo et al., 1999; Elsayed et al., 2007). In some males and females from subtropical goat breeds, the reproductive seasonality is controlled mainly by changes in photoperiod (Delgadillo et al., 2004; Duarte et al., 2010). Thus, it is possible to modify their annual rhythm of reproduction by using an artificial photoperiod to induce a reproductive activity during the

* Corresponding author. Tel.: +52 871 729 7641.
E-mail address: joaldesa@yahoo.com (J.A. Delgadillo).

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sexual rest season in both sexes: following 2–3 months of artificial long days, artificial short days stimulates ovulation and testosterone secretion (Delgadillo et al., 2002, 2004; Duarte et al., 2010).

In addition to photoperiod, socio-sexual relationships can induce ovulations during the seasonal anestrous. In fact, the introduction of a male into a group of seasonal anestrous goats can stimulate estrus and ovulation in the first 5 days of contact between sexes (Bedos et al., 2010; Fernández et al., 2011; Pellicer-Rubio et al., 2007). This phenomenon is called the male effect (Chemineau, 1987; Delgadillo et al., 2009; Shelton, 1960). The sexual response of goats exposed to the male effect is strongly influenced by the sexual behavior displayed by males. Indeed, in ewes, a greater proportion of females ovulated when exposed to males having a high capacity to service than in those in contact with males with a lower capacity of service (Perkins and Fitzgerald, 1994). In goats, all females ovulated when exposed to males rendered sexually active during the sexual rest by exposure to long days followed by natural photoperiod variations; in contrast, no females ovulated when exposed to non-treated males that were in sexual rest (Delgadillo et al., 2002). The high proportion of goats that ovulated when exposed to the photo-stimulated bucks could be caused by the strong stimulation provided by the sexual behavior, odor, and vocalizations of males; these cues stimulate the endocrine and sexual activities in seasonally anestrous goats (Delgadillo et al., 2002, 2012; Fernández et al., 2011; Rivas-Muñoz et al., 2007). In addition to the improvement of the exteroceptive cues provided by the males submitted to the long-days treatment, the high ovulatory proportions of females that ovulated when exposed to the photo-stimulated males could be due to the daily exchange of photo-stimulated bucks between groups (Bedos et al., 2010, 2012; Fernández et al., 2011; Fitz-Rodríguez et al., 2009). This hypothesis is supported by data regarding the activation of sexual activity in males from different species when exposed to a novel female or to a familiar one after a period of separation. In sexually satiated male mice, the presence of a novel female restores his mating activity (Wilson et al., 1963). In bucks, rams, and bulls, the presence of a novel female stimulated the sexual behavior of males, probably by an immediate enhancement of LH and testosterone secretion (bulls: Bailey et al., 2005; bucks: Prado et al., 2002, 2003; rams: Gonzalez et al., 1988; Pepelko and Clegg, 1965; Thiery and Signoret, 1978).

Therefore, the aim of this study was to determine the influence of daily rotations of photo-stimulated males among subgroups on the ovulatory response of seasonally anestrous goats. We hypothesized that a large proportion of goats would ovulate when photo-stimulated males are rotated daily among subgroups, as a consequence of a greater display of their sexual behavior. To test our hypothesis, seasonal anestrous goats were exposed to photo-stimulated males: in one group, males remained with the same females that were divided in three subgroups (one male per subgroup); in the other one, females were also divided in three subgroups (one male per subgroup) and males were rotated daily among them throughout the study duration.

2. Materials and methods

2.1. General conditions

This study was performed in April, during the non-breeding season, using local goats from subtropical Mexico (for review see Delgadillo, 2011). We used sexually experienced male goats and multiparous, seasonally anovulatory females. Goats had given birth in November and December and kids had been weaned at about 30 d of age. Females were divided in two groups balanced for body condition score (BCS: range, 1–4; 1 = very lean, 4 = fat; Walkden-Brown et al., 1997): the fixed-group ($n = 36$; BCS: 1.9 ± 0.04; mean ± SEM) and the rotated-group ($n = 34$; BCS: 1.9 ± 0.05; see male effect section below). Both groups of females were divided in three subgroups. The distance between both groups of females was about 100 m to prevent any risk of interference by the treatments between groups. All females were machine-milked daily during the experiment and isolated from any male from December 15th until April when exposure to males was implemented (see male effect section below). Females and males were fed 1.5 kg of alfalfa hay (18% CP) and 100 g of commercial concentrate (14% CP; 1.7 Mcal/kg) with free access to water during the study. The animals were maintained under good management conditions that fulfilled their nutritional requirements; the experimental procedures were in strict accordance with the Guide for Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 2010).

2.2. Sexual activation of male goats by a long-day treatment

Males were kept together in a shaded open pen ($n = 6$; 6×10 m). These males were rendered sexually active from February to April, months corresponding to the natural sexual rest, as described previously (Delgadillo et al., 2002). Briefly, males were exposed to artificial long days (16 h of light per day) from November 1st to January 15th. From January 16th onwards, males were exposed to natural variations of photoperiod. This photoperiodic treatment stimulates testosterone secretion, sexual behavior, and odor in the photo-stimulated bucks from February to April (Delgadillo et al., 2002; Rivas-Muñoz et al., 2007). In the current study, we did not utilize photoperiodic-untreated males, because we have already demonstrated that they do not stimulate the sexual activity of anestrous goats even when they were rotated daily between subgroups of does (Flores et al., 2000; Delgadillo et al., 2002).

2.3. Preparation of females

On March 23rd and April 2nd, the ovarian cyclicity of all goats was determined via transrectal ultrasonography using an Aloka SSD-500 device connected to a transrectal 7.5 MHz linear probe (Delgadillo et al., 2011; Simões et al., 2007). Just after the ultrasonography was ended, females were divided into two groups balanced for body