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One day of contact with photostimulated bucks is sufficient to induce ovulation in seasonally anestrous goats

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ABSTRACT

In seasonally anovulatory goats, daily contact with photostimulated bucks for 15 days stimulates ovulations in most females. In this study, we determined whether ovulation could be induced in goats exposed to photostimulated bucks for less than 15 days. Bucks were rendered sexually active during the nonbreeding season by exposure to 2.5 months of long days from November 1. The control group of females was exposed to one photostimulated buck for 15 days (n = 12). Other three experimental groups were exposed to males (n = 1 per group) for 1, 5, or 10 days (n = 14 or 15 females per group). Ovulations were determined by measurement of daily plasma progesterone concentrations during 17 days. All females from the control and experimental groups ovulated at least once during the experiment ($P > 0.05$). Furthermore, the proportions of goats that displayed a short luteal phase followed by a new ovulation, or a normal luteal phase after being in contact with males, did not differ between groups depending on the duration of time of contact with the photostimulated males ($P > 0.05$). In contrast, the proportions of females that displayed a short luteal phase followed by anovulation were greater in goats in contact with males for 1 day than in those in contact with males for 10 and 15 days ($P < 0.05$), whereas they did not differ from females exposed to males for 5 days ($P > 0.05$). We conclude that 1 day of contact with sexually active males is long enough to stimulate the ovulatory activity in seasonally anovulatory goats. However, a significantly higher proportion of females exposed to males for 1 day did not ovulate again after showing a short luteal phase.

1. Introduction

The sociosexual relationships, particularly the "male effect," can be used to stimulate the activity of the hypothalamo–pituitary–ovarian axis in goats and ewes during the seasonal anestrus [1–3]. Indeed, the introduction of a male into a group of anovulatory females can induce and synchronize LH secretion, ovulations, and estrous behavior in the following 5 days [3–5]. In goats, the response of females exposed to males involves an immediate increase of LH secretion that culminates in a preovulatory surge leading to ovulation [6–8]. A variable number of females show estrous behavior at the first induced ovulation 2 to 5 days after male introduction. Most goats have a short ovarian cycle of 5 to 7 days of duration, followed by a second ovulation, which usually occurs around 7 to 10 days after the introduction of the male and which is associated with estrous behavior and followed by a luteal phase of normal duration [9,10].

The proportions of females that ovulated vary according to the intensity of the sexual behavior displayed by males to which they are exposed [11–13]. Indeed, most of goats or

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ewes ovulated and showed estrous behavior when they were exposed to bucks or rams displaying an intense sexual behavior, as opposed to those in contact with males displaying a weak sexual behavior [13–15]. In goats, e.g., most of does (>90%) ovulated when they were exposed to bucks rendered sexually active by exposure to long days in autumn to winter, whereas a low proportion of females (<10%) did so when exposed to those in seasonal rest [11].

Duration of contact period between males and females is another factor involved in the ovulatory response of females exposed to males, probably because LH secretion decreased when males are removed from females, preventing ovulation to occur [16]. In fact, only 18% of ewes ovulated when exposed to wethers treated with testosterone for 1 day, but this percentage increased to 53% and 61% when the males were maintained with females for 4 or 15 consecutive days, respectively [17]. Similarly, in cashmere goats, only 24% of females ovulated when exposed to males for 16 h/day during 10 days, but this percentage increased to 95% when bucks remained with females 24 h/day during the same duration [18]. In contrast to the previously described results, in local goats from subtropical Mexico, most of goats (>92%) displayed estrous behavior when the time of contact with males was reduced from 24 hours to 16 h/day during 18 days [14]. Interestingly, recent studies indicate that most of Mexican goats ovulated and became pregnant when daily contact between photostimulated males and females was further reduced from 24 hours to 4, 2, or even 1 hour for 15 days [6,19,20]. The different results described in ewes versus cashmere and Mexican goats can be explained by the fact that Rivas-Muñoz et al. [14] and Bedos et al. [6,19,20] used males rendered sexually active by exposure to a long-day photoperiodic treatment [11,21], whereas Signoret et al. [17] and Walkden-Brown et al. [18] used photoperiodic-untreated males, which were in seasonal sexual rest. In fact, the high level of sexual behavior, the intense odor, and vocalizations showed by bucks induced by long-day treatments are important cues to induce endocrine and reproductive activities in anestrous goats [7,14,22]. Considering the high proportions of goats that ovulated when exposed to sexually active bucks for a short duration, we set the hypothesis that sexually active males could be able to induce ovulations in goats when permanent daily (24 h/day) contact between sexes is less than 15 days.

2. Materials and methods

2.1. Ethical note

The experimental procedures used in the current experiment were in accordance with the Official Mexican Rule for the technical specifications for the production, care, and use of laboratory animals [23].

2.2. Location and general management conditions of animals

The current experiment was performed in the region of Laguna, in the state of Coahuila, Mexico (latitude, 26°23′N and longitude, 104°47′W). In female local goats, the anestrous season lasts from February-March to August-September [24], whereas in bucks, the sexual rest lasts from January-February to May-June [25]. All females were multiparous and had given birth between October and December and were milked manually once daily during the study. Females and males were fed with 2 kg of alfalfa hay (18% crude protein) and 200 g of commercial concentrate (14% crude protein; 1.7 Mcal/kg) with *ad libitum* access to water during the study.

2.3. Management of experimental groups

Multiparous anovulatory goats used in the present experiment were 2 to 3 years old at the beginning of the experiment. On March 15 and 21, each female was submitted to a transrectal ultrasonography using an Aloka SSD-500 scanner connected to a transrectal 7.5-MHz linear probe to determine its ovarian cyclicity [26,27]. Taking into account the duration of follicular phase in does [28], this observation, associated with the measurement of progesterone concentration in a blood sample taken immediately before introduction of males (see in the following), is efficient for the determination of the anovulatory state of these females [19,29]. There was not any doe cycling before introduction of males, which is indicative of depth of anestrus [4]. On April 1, females were assigned to four groups balanced for body condition score (average body condition score between 2 and 2.2 on a scale ranging from 1, very thin, to 4, very fat [30]; Table 1). These four groups remained in shaded open pens under natural day length during 15 days and were exposed to photostimulated males. The photoperiodic treatment consisted in exposing the males to 2.5 months of long days (16 hours of light per day) from November 1 followed by exposure to natural photoperiodic conditions. Long days were provided with natural light and artificial light from 6 AM to 8 AM and from 6 PM to 10 PM. Intensity of artificial light was at least 300 lx at the level of eyes of the animals. This photoperiodic treatment stimulates testosterone secretion, sexual behavior, and vocalizations of bucks in March and April, during the natural sexual rest when control males are sexually inactive [11,22].

2.4. Male effect

On April 3 (Day 0; 8 AM), the four groups of females were exposed to the photostimulated entire bucks (n = 1 male/group). The positive control group remained in contact with males for 15 days (n = 12). The experimental groups were in contact with males for 1 (n = 15), 5 (n = 15), or 10 days (n = 14; Fig. 1). In groups of does exposed to male for 5, 10, and 15 days, male from each group was daily switched between groups to avoid a possible individual effect in the response of females to the presence of males because of different individual buck behavior and possible habituation of does. The distance between each group of females was more than 100 m to prevent any risk of interference between groups due to the presence of the males [19]. To ensure that all photostimulated males were sexually active, their sexual behavior was observed for 15 minutes after their introduction in the groups of