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Reproductive performance response to the male effect in goats is improved when doe live weight/body condition score is increasing

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ABSTRACT

This study examines the nutritional and metabolic cue-induced modulation of the reproductive performance response of female goats to the male effect. During natural anoestrus, 48 Blanca Andaluza does were isolated from bucks for 45 days and distributed into two groups: (1) low body weight (BW)/low body condition score (BCS) animals (LL-gain group, $N = 18$), which were fed 1.9 times their maintenance requirements; and (2) high BW/high BCS animals (HH-loss group, $N = 30$), which were fed 0.4 times their maintenance requirements. Following isolation, oestrous activity was recorded daily by visual observation of the marks left by harness-equipped males. Weekly blood samples were taken for the determination of progesterone, glucose, insulin, non-esterified fatty acids (NEFAs) and leptin concentrations. Fecundity, fertility, prolificacy and productivity were also determined. Significantly greater ovarian and oestrous responses, and productivity, were observed in the LL-gain group compared to the HH-loss group ($P < 0.05$). After the introduction to the males, no differences in NEFA concentration were seen between the groups; before introduction the values were higher in the HH-loss group. At the moment of detection of oestrus following male introduction, the insulin concentration of the LL-gain animals was higher ($P < 0.05$). The present results show that the reproductive performances of does subjected to the male effect in spring are poorer in those with a decreasing BW and BCS and better in those with increasing scores. This might be explained by the differences between groups in terms of their plasma insulin concentrations. The NEFA concentration was clearly modified by introduction to the males.

1. Introduction

Goats are seasonal breeders, with ovarian activity occurring during the autumn and winter months. Photoperiod, through its influence on the hypothalamic-pituitary axis (Lincoln and Short, 1980; Zarazaga et al., 2011abc), is the main cue governing reproductive activity. However, other environmental stimuli, such as social interactions and food availability (Walkden-Brown et al., 1993; Mani et al., 1996), should not be disregarded as potential modulators of reproductive seasonality. In practice, seasonal anoestrus can be avoided by the 'male effect', induced through the exposure of anoestrous females to intact males (for details see the review by Delgadillo et al., 2009). At Mediterranean latitudes this is a commonly followed procedure in extensive and semi-extensive stockraising systems. However,

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the results of the male effect depend greatly on factors such as breed, the type of previous isolation, the depth of anoestrus, postpartum stage, parity number, nutrition, and body condition (Walkden-Brown et al., 1993; Cerbito et al., 1995; Urrutia et al., 2003; Veliz et al., 2009; Delgadillo et al., 2009).

Nutrition clearly affects reproductive function in domestic ruminants. In Mediterranean extensive or semi-extensive systems, food availability in spring – when the male effect is practised – can vary widely, and animals may experience increases or reductions in body weight (BW) and body condition score (BCS) that can modify male effect results. Certainly it is greater when female BW (Veliz et al., 2006) is higher, and nutritional imbalance resulting in weight loss can lead to the premature cessation of breeding activity (Zarazaga et al., 2005, 2011a,b,c). Poor BCS has also been associated with reduced reproductive performance responses to the male effect in goats (Urrutia et al., 2003). However, Rosales-Nieto et al. (2011) reported the male effect to induce oestrus in does during late anoestrus irrespective of the latters' BCS and BW as long as their nutritional requirements were being fulfilled (100% or 150%). Unfortunately, all the latter studies involved animals of static BW or BCS; none involved any with a changing BW or BCS.

It was hypothesized that, at Mediterranean latitudes, the reproductive performance response to the male effect in does differs depending on whether the latter are experiencing increasing or decreasing BW and/or BCS, and that metabolic or nutritional factor(s) underlie the response. The aims of the present work were therefore to determine: (1) how the reproductive performance response to the male effect differs depending on whether doe BW and/or BCS is increasing or decreasing, and (2) whether metabolic/nutritional factors explain any of the responses observed.

2. Materials and methods

2.1. Study conditions

All procedures were performed by trained personnel in strict accordance with Spanish guidelines for the protection of experimental animals (RD 53/2013), and in agreement with European Union Directive 86/609. The study was conducted at the University of Huelva experimental farm (37°20′N, 6°54′W), which meets the requirements of the European Community Commission for Scientific Procedure Establishments (2010/63).

2.2. Animals and management

On March 20th (Day 0), during seasonal anoestrus, 48 adult (3 years old), non-pregnant, Blanca Andaluza does were divided into two groups depending on their BW and BCS (based on a scale of 0 = emaciated to 5 = very fat, with increments of 0.25 [Hervieu et al., 1991]): (1) low BW (mean ± s.e.) (37.0 ± 1.5 kg)/low BCS (2.53 ± 0.04), known as the LL-gain group since these animals were fed 1.9 times their maintenance requirements (N = 18); and (2) high BW (40.7 ± 1.3 kg)/high BCS (2.89 ± 0.07), known as the HH-loss group since these animals were fed 0.4 times their maintenance requirements (N = 30). The does followed these nutrition regimens, which were designed according to INRA standards (Morand-Fehr and Sauvant, 1988), for a total of 98 days. During the two week period before isolation from the males (Day 14), ovarian cyclicity in the does was confirmed by their plasma progesterone concentrations (determined weekly). They were deemed cyclic if their progesterone concentration was >0.5 ng/mL in at least two samples. This has been shown indicative of ovulation in Payoya goats (Zarazaga et al., 2005, 2009).

Each group was housed in a separate pen under natural photoperiod conditions. The feed provided to both groups was a commercial concentrate composed of maize (23.0%), oats (24.7%), peas (20.4%), barley (16.3%), lucerne pellets (12.2%), and a mineral-vitamin complement (3.4%). The nutritional values of the feed were 0.94 milk fodder units (UFL) and 77 g of digestible protein/kg of dry matter. This concentrate was offered individually once per day. In addition, barley straw, distributed to each group as a whole, provided 0.37 UFL and 25 g of digestible protein/kg dry matter. All animals had free access to water and mineral/vitamin blocks. The aim of the feeding regimens was that, at the time of introduction to the males, the does of the LL-gain group would have about the BW and BCS originally shown by the does of the HH-loss group, and that the does of the HH-loss group would have about the BW and BCS originally shown by the does of the LL-gain group.

2.3. Preparation of the males

On the same day that the females were originally divided into their groups, five bucks received two subcutaneous melatonin implants each containing 18 mg of melatonin (Melovine®; CEVA Salud Animal, Barcelona, Spain) at the base of the left ear to stimulate their libido during what would otherwise be their normal sexual rest period (Zarazaga et al., 2010).

2.4. The male effect

On Day 59 (following the 45 days of isolation of the does from all males), five males with marking harnesses were placed in contact with the females (two with the LL-gain does and three with the HH-loss does) and maintained with them for the following 39 days.

2.5. Measurements

2.5.1. Detection of oestrous behavior

Oestrous activity was recorded every day by direct visual observation of the marks left by the marking harnesses (Walkden-Brown et al., 1993).

2.5.2. Detection of ovulation

The occurrence of ovulation and ovulation rate were assessed by the number of corpora lutea observed in each female by transrectal ultrasonography conducted 6–8 days after the detection of oestrus (Simoes et al., 2005). The procedure was performed using an Aloka SSD-500 (Ecotron, Madrid, Spain) apparatus connected to a 7.5 MHz linear