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Postpartum ovarian activity of Santa Inês lactating ewes fed diets containing soybean hulls as a replacement for coastcross (*Cynodon* sp.) hay

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ABSTRACT

The Santa Inês, a Brazilian hair sheep, has a non-seasonal breeding activity. Data regarding the duration of the postpartum anestrous period in Santa Inês lactating ewes is lacking and the objective of this trial was to determine the effects of replacing neutral detergent fibre (NDF) provided by coastcross (*Cynodon* sp.) hay with NDF contained in soybean hulls (SH) on the postpartum ovarian activity—as measured by the serum progesterone (P_4) concentration. Fifty-six lactating ewes (body weight 56.1 ± 6.8 kg) were individually penned and used in a randomized complete block design with 14 blocks and four treatments. The SH NDF replaced 33 (SH33), 67 (SH67), or 100% (SH100) of the NDF contributed by coastcross hay in the control diet (SH0). This resulted in a SH inclusion at rates of 0, 25, 54, and 85% of the dietary dry matter (DM). Blood samples were collected twice weekly from the 14th to 84th day postpartum and the serum P_4 concentrations determined by radioimmunoassay (RIA). It was estimated that the 1st postpartum ovulation occurred 6 days before the date that a serum $P_4 \geq 1$ ng/ml concentration was first recorded. The mean body condition score (BCS; 0–5 scale) was 3.0 ± 0.19 on day 14 postpartum and the mean BCS at day 56 postpartum increased linearly ($P < 0.01$) with the inclusion levels of SH (3.09, 3.24, 3.34, and 3.36, respectively). Treatments did not differ significantly in the induction of postpartum days to the resumption of ovarian luteal activity (34.1 ± 15.3 days postpartum). On days 25, 50, and 75 postpartum 36, 80, and 100% of the ewes had resumed ovarian activity, respectively. Non-esterified fatty acid concentration decreased quadratically ($P < 0.05$) with the SH inclusion, with values of 0.323, 0.244, 0.204, and 0.216 mequiv./l for the SH0, SH33, SH67, and SH100 treatments being recorded, respectively. Replacement of the NDF provided by coastcross hay with the NDF from the SH did not influence the duration of the postpartum anestrous period in Santa Inês lactating ewes. Considering a 150-day gestation period and the 34 days postpartum anestrous demonstrated in the present study, the current production system of a lambing interval of 8 months (3 lambing events in 2 years) may not be optimizing the production potential and a system in which the lambing interval is shortened by at least 1 month may be feasible.

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1. Introduction

Wool sheep breeds generally show a seasonal reproductive pattern, with photoperiod being the key factor that dictates the estrous behavior (Hafez and Hafez, 2000). Sheep are generally considered to be short-day breeders, showing sexual activity in response to decreasing daylight length in the late summer to early autumn. However, in the tropical and sub-tropical environments, ewes may be completely non-seasonal or intermittently polyestrous with the quality and availability of nutrients dictating the breeding activity (Rosa and Bryant, 2003).

The Santa Inês breed is a non-seasonal hair sheep originating in Northeastern Brazil and has been utilised primarily for meat production (Sasa et al., 2002; Coelho et al., 2006). These Santa Inês lambs have a lower growth potential in terms of average daily gain (ADG) than other meat-type lambs (Figueiredo et al., 1990) with an ADG ranging between 230 and 280 g/day under intensive conditions (Rocha et al., 2004; Urano et al., 2006). Despite this characteristic, the reproductive advantage of the Santa Inês, compared to the other seasonal sheep breeds, results in its widespread use in commercial Brazilian flocks.

An 8-month lambing interval is typically recommended for accelerated breeding programs (3 lambing events in 2 years) in Brazil. Data to support this recommendation in terms of the duration of the postpartum anestrous period in Santa Inês ewes is however not available. The duration of the postpartum anestrous period is a critical determinant of the optimal time to initiate the breeding season in an accelerated production system. In non-seasonal breeds of sheep, nutritional management is, however, the most important factor affecting the length of the postpartum anestrous interval (Lindsay, 1991). Ewes require maximum energy during early lactation (NRC, 2007) and meeting these requirements is essential to support adequate milk production for maximum lamb growth and to allow rapid resumption of postpartum ovarian activity—especially in such an accelerated breeding system. Low energy intake during this period has been demonstrated to extend the postpartum anestrous period (SID, 1992).

Soybean hulls (SH) contain 60% neutral detergent fibre (NDF; cellulose, hemicellulose, and lignin), 45% acid detergent fibre (ADF; cellulose and lignin), and only 2.5% lignin (NRC, 2001). When fed as an alternative fibre source, SH can be used to maintain the NDF concentrations, while increasing the energy concentration of the diet in ruminants (Ipharraguerre and Clark, 2003). Thus, the replacement of forage with SH could be a strategy to help in reducing the length of the postpartum anestrous period in sheep. Hence, the objective of this trial was to determine the effects of replacing NDF provided by coastcross hay with equal amounts of NDF provided by SH on the resumption of postpartum ovarian activity in Santa Inês ewes—measured via the serum progesterone (P_4) concentrations. The influence of this compositional and energy change in the diet on non-esterified fatty acids (NEFA) and body condition score (BCS) was also assessed as indicators of the nutritional status of the ewes.

2. Materials and methods

This study was conducted from April to June 2004 (autumn) at the sheep facility of the Department of Animal Science, Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, located at Piracicaba (22°42′24′′S and 47°37′53′′W), in the state of São Paulo, Brazil.

2.1. Animals and housing

Fifty-six Santa Inês lactating ewes with an initial mean body weight (BW) of 56.1 ± 6.8 kg were housed indoors and individually allotted with their lambs to pens (1.3 m × 3.5 m) with a concrete floor, feed bunk, mineral box and water trough. During the trial, all ewes were kept isolated from the rams. All ewes were dewormed on the day of lambing with 5 ml 5% levamisole chloridate (Fort Dodge Saúde Animal, Campinas, Brazil) and 1 ml 1% moxidectin (Fort Dodge Saúde Animal, Campinas, Brazil).

2.2. Experimental design and treatments

After lambing, all animals were assigned to a randomized complete block design, with 14 blocks and four treatments. The blocks (4 ewes each) were balanced regarding parity (primiparous, $n = 8$; multiparous, $n = 48$), number of lambs reared (single, $n = 44$; twins, $n = 12$), gender of offspring (female, $n = 36$; male, $n = 32$) and lambing date (variation of less than 7 days). Ewes within each block were allocated randomly to the experimental diets.

The control diet which contained no soybean hulls (SH0) consisted of 71.8% of coastcross hay (Table 1). The SH were used to replace 33 (SH33), 67 (SH67), or 100% (SH100) of the NDF contributed by coastcross hay. Since the NDF concentration of coastcross hay (75.0%) was greater than the NDF concentration of SH (65.2%), the proportion of dietary dry matter (DM) contributed by SH in the experimental diets were 0, 25, 54, and 85% for the SH0, SH33, SH67, and SH100 treatments, respectively. Diets were formulated to meet the NRC (1985) recommendations for lactating ewes and provide similar concentrations of crude protein (CP).

2.3. Feeding management, data collection, and analysis methods

All ewes were offered the same prepartum diet (57.0% corn silage, 25.7% ground corn, 14.3% soybean meal, 0.9% urea, 1.0% limestone, and a 1.1% mineral premix—with 42.0% DM, in the as-fed basis, and 15.6% CP, 29.8% NDF, 16.9% ADF, 3.9% ash, and 1.8 Ca:P; on a DM basis, respectively). Ewes were adapted to their experimental diets from the 7th to 13th day postpartum by replacing 50% of the prepartum diet with the experimental diet from the 7th to 10th day, and then total replacement from the 11th to 13th day. Lactating ewes were 14.6 ± 2.6 days in milk at the onset of the trial and the lambs were weaned 56.6 ± 2.6 days following lambing.

The total mixed diets were offered every other day at 08:00 and all animals had *ad libitum* access to the feed and fresh water. The hay was coarsely chopped to reduce diet selection and feed wastage and the hay particle size distribution was determined by the Penn State Particle Size Separator method (Heinrichs, 1996). The particle size distribution was >19 mm = 66.5%; 7.9–19 mm = 3.7%; and <7.9 mm = 29.8%. Monensin sodium (active compound) (25 mg) was added per kg of diet (as-fed basis) as an anti-coccidiostat and mixed beforehand with the concentrate.

Samples from each experimental diet were sampled weekly and immediately frozen (−18 °C). After thawing, samples were dried in a ventilated air oven (55 °C) for 72 h, and ground with the aid of a Wiley mill to pass through a 1 mm sieve. The DM content was determined by drying (105 °C) for 24 h, and the organic matter (OM) by heating (550 °C) for 4 h. The ether extract (EE) content was also determined according to the AOAC (1990) and nitrogen content determined using a Leco FP528 (Leco Corporation, St. Joseph, MI) combustion nitrogen analyser (AOAC, 1997) and the NDF determination using beakers according to Van Soest et al. (1991), with the addition of heat-stable α-amylase and sodium sulfite. The NDF concentrations were corrected for ash and the non-fibre carbohydrates (NFC; on DM basis) were estimated as NFC = 100 − (%NDF + %CP + %EE + %ash). The dietary metabolizable energy (ME) and the net energy for lactation (NE_L) were determined by using the small ruminant nutrition system, version 1.8.0 (Cannas et al., 2004).

Blood samples were collected by jugular venipuncture twice weekly (Wednesday and Saturday) from the 14th to 84th day postpartum using Vacutainer® tubes containing a serum separator gel and coagulating activator. Serum was immediately separated by centrifugation at 1900 × g for