

Is the Santa Inês sheep a typical non-seasonal breeder in the Brazilian Southeast?

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Abstract This study aimed to characterize the annual reproductive cycle of Santa Inês sheep in the Fluminense lowland region (latitude 22° 27' 45" south, Rio de Janeiro, Brazil) between September 2011 and August 2012. Ten ewes were maintained in a semi-intensive system under natural photoperiods with access to pasture and shelter. Blood samples were collected every 2 weeks to determine plasma progesterone concentrations. The body condition score (BCS) was determined each month. There was no seasonal variation in the plasma progesterone concentration from the months of September to January, April, and May to August. In the months of February and April, the plasma hormone levels were higher than August to November. Seventy percent (7/10) of the sheep studied had short seasonal anestrus. The periods of anestrus were concentrated between the months of September and December (spring season) in 85.7 % (6/7) of the cases evaluated. In these cases, 57.1 % (4/7) also had short periods of reproductive inactivity during other months of the year. The progesterone values obtained in the spring corroborate the higher reproductive anestrus observed in this season. Higher plasma progesterone values were found in summer and autumn with reduction in the winter to lower values in the spring. No changes in the BCS during the study period were

observed. Under the studied conditions, the Santa Inês sheep showed a low degree of reproductive seasonality. However, some individual ewes had seasonal anestrus during the spring. Further studies that include management techniques are needed to improve reproductive efficiency without hormone therapy in this breed under tropical conditions.

Keywords Cyclicity · Reproductive seasonality · Tropical hair sheep · Progesterone

Introduction

Sheep provide protein of high biological value that is derived from their milk and meat. The range of products offered is easy to trade because the market demand is high and has not yet been met (Livestocknet 2006). One option for boosting the production chain and making breeding economically viable is the implementation of an efficient system of reproductive management (Fatet et al. 2011). In this context, assisted reproduction with the use of hormonal protocols based on the use of intravaginal devices containing progestogens offers several advantages (Abecia et al. 2011). However, in the last decade, a preference in the European community for obtaining animal products using green, clean, and ethical methods has been observed. This preference includes products obtained by alternative methods that do not use the hormonal preparations commonly applied in the field (Scaramuzzi et al. 2006).

Among the national herds, the Santa Inês breed has meat production potential in crossbreeding as maternal basis due to maternal ability, good prolificacy, and rapid reproductive maturation. Additionally, this hair sheep is adapted to tropical conditions (Rocha et al. 2004). The breed may be used as an alternative to the conventional hormonal methods for the induction of estrus because studies in the Southeast region have demonstrated its low degree of reproductive seasonality

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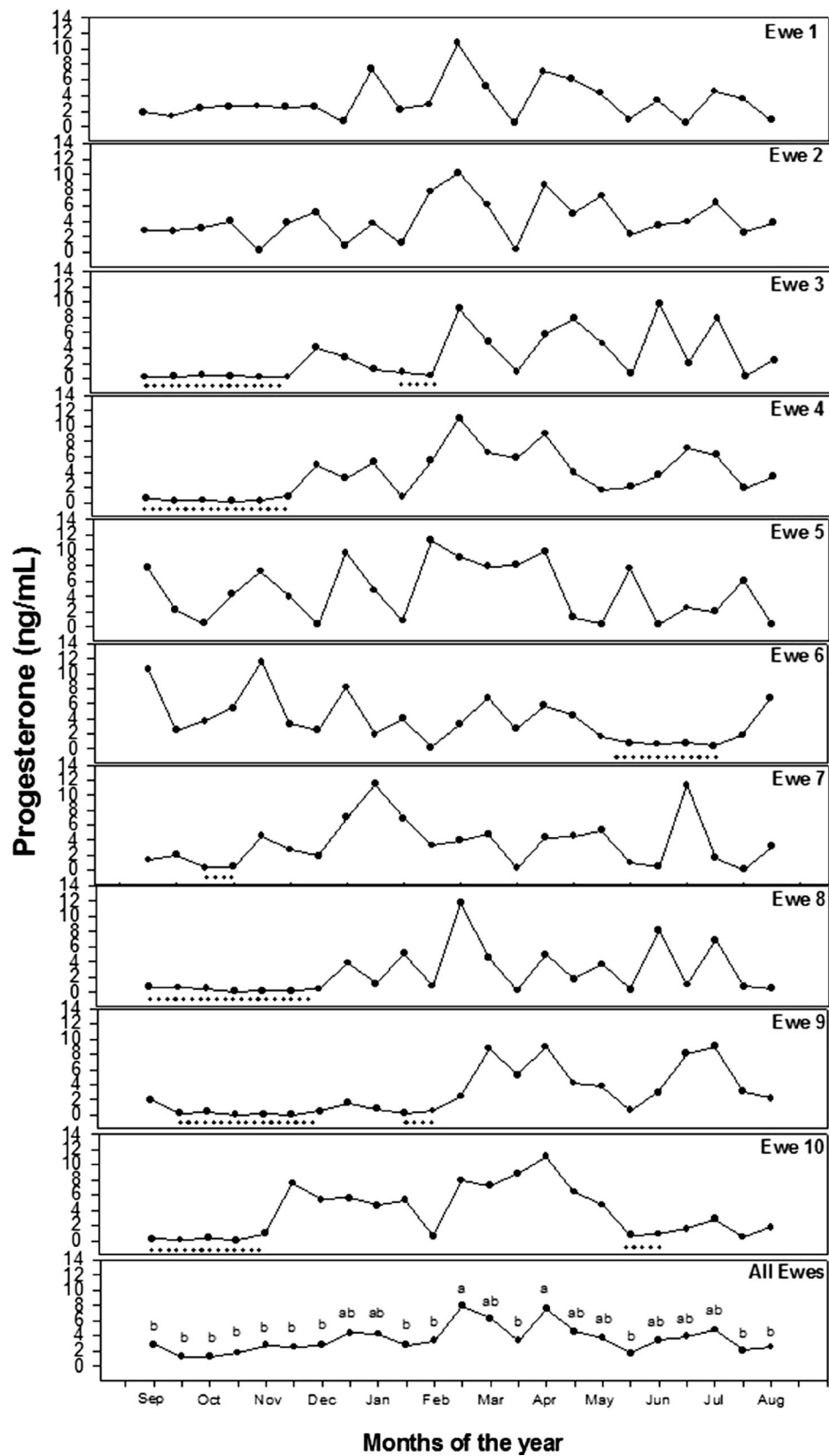


Fig. 1 Biweekly plasma progesterone concentration in Santa Inês ewes between September 2011 and August 2012 (solid black line). Cyclical and non-cyclical ewe state (dotted line). (a b) Values without a common lowercase letter differ within each row at $P < 0.05$ (Bonferroni test)

(Coelho et al. 2006; Rodrigues et al. 2007; Sasa et al. 2011). In Santa Inês ewes, seasonality appears to be conditioned by other factors, such as the age and nutritional status of the animals (Sasa et al. 2002).

The determination of plasma progesterone concentration has been used as a method of monitoring the cyclic activity in ewes (Guerin et al. 2000; Zarazaga et al. 2003; Sasa et al. 2011). Females are considered to be in an anovulatory period (anestrus) when their plasma progesterone concentration remains below 1.0 ng/mL for more than two consecutive blood samples for a period equal to or greater than 10 days (Minton et al. 1991).

Therefore, to guide farmers in the adoption of a hormonal protocol, the aim of this study was to characterize, using the plasma progesterone concentration, the annual reproductive cycle of Santa Inês ewes under tropical conditions in Rio de Janeiro, Brazil.

Materials and methods

The duration of this study was 12 months (September 2011 to August 2012), and it was conducted at the sheep unit of the Cachoeiras de Macacu Farm School belonging to the Veterinary School, Fluminense Federal University. The latitude of 22° 27' 45" south, the longitude of 2° 39' 11" west, and the altitude was 577 m above sea level. According to Köppen, the climate is a tropical hot-humid type, with temperatures throughout the year ranging from 15 to 30 °C and an annual rainfall ranging from 2.200 to 2.600 mm concentrated mostly in the summer. This research was reviewed and approved by the Animal Care Committee of Fluminense Federal University and was conducted under the ethical principles of the Brazilian Society of Laboratory Animal Science.

Ten nulliparous Santa Inês sheep with an initial mean age of 21.0±4.0 months, an average weight of 38.7±7.1 kg, and a body condition score average (BCS) of 3.07±0.3 were used. The experimental animals were maintained in a semi-intensive system under natural photoperiods with access to pasture and shelter. To meet their nutritional needs, based on a recommended total daily dry matter intake of 3 % of the live

weight (NRC 2007), chopped elephant grass (*Pennisetum purpureum*) was offered twice daily, and 300 g per animal of a concentrate with 17 % crude protein was offered once a day. The sheep were given water and mineral salt (Ovinofos®, Tortuga, São Paulo, Brazil) ad libitum.

The BCS was measured monthly as described by Pugh and Baird (2011). Blood samples were collected from the ten ewes every 2 weeks by jugular venipuncture into vacutainer tubes (Vacutainer®, England, UK) containing EDTA (10 %). The plasma was immediately separated by centrifugation at 1500×g for 15 min and stored at −20 °C until it was analyzed for progesterone concentration by radioimmunoassay (RIA) using a commercial kit (Coat-a-Count®, Diagnostic Products Company, Los Angeles, CA, USA). The detection limit was 0.09 ng/mL. The intra- and inter-assay coefficients of variation were 6.3 and 15.8 %, respectively. The cyclic and non-cyclic states of the ewes were interpreted according to Minton et al. (1991).

The results were analyzed using the Statistical Analysis System program (SAEG® 9.0, Universidade Federal de Viçosa, Viçosa, MG, BRA). The variables were subjected to ANOVA for the linear models, and the mean values from all ewes were compared using the Bonferroni method (evaluated every 2 weeks) or the Tukey's test (seasonal evaluation) at the 5 % significance level.

Results

The plasma progesterone values for the individuals and the group of the Santa Inês sheep are shown in Fig. 1 (solid black line). Regarding group values, there was no seasonal variation in the plasma progesterone concentration from the months of September to January, April, and May to August. In the months of February and April, the plasma hormone levels were higher than August to November. Concerning individual values, the cyclic and non-cyclic states of the ewes are shown in Fig. 1 (dotted gray line). Seventy percent (7/10) of the ewes studied had short to medium seasonal anestrus. Only 30 % (3/10) showed no signs of reproductive seasonality. The

Table 1 Plasma progesterone concentrations and body condition scores of the ten Santa Inês ewes according to seasons

Variable	Season				Season average
	Spring	Summer	Autumn	Winter	
Plasma progesterone concentration (ng/mL)	2.04c±2.29	4.81a±3.38	4.3ab±3.04	3.20bc±2.91	3.52±2.91
Body condition score (1–5)	3.11±0.19	3.07±0.21	3.08±0.28	3.03±0.18	3.07±0.22

Values without a common lowercase letter differ within each row at a $P<0.05$ (Tukey's test)

anestrus period was concentrated between September and December (the spring season) in 85.7 % (6/7) of the ewes evaluated. Of these ewes, 57.1 % (4/7) also had short periods of reproductive inactivity during other months of the year. Only six of the ewes showed anestrus between late May and early July. No changes in the BCS during the study period were observed.

The effect of season on plasma progesterone values was observed (Table 1). The lower levels obtained in the spring corroborate the greater reproductive seasonality found in this season. Higher plasma values were observed in summer and autumn, with a reduction in the winter to lower values in the spring. Additionally, no changes in the BCS according to season were observed.

Discussion

In the present study, the Santa Inês ewes had mean plasma progesterone concentrations similar to those reported previously (Coelho et al. 2006; Cavalcanti et al. 2012; Pinna et al. 2012) who obtained values of 2.6 (annual), 3.2 (summer), and 2.2 ng/mL (spring) respectively in sheep at similar latitudes. Based on the data used for the biweekly plasma progesterone curve (Fig. 1), it can be inferred that the flock studied showed an annual poliestric profile, corroborating previous studies reporting a low degree of reproductive seasonality in Santa Inês sheep (Coelho et al. 2006; Rodrigues et al. 2007; Sasa et al. 2011). However, higher plasma hormone levels in the months of February, March, and April (late summer and early fall) were observed. Consistent with the expected result, shortening daylight is a natural stimulus for breeding during these months.

The individual assessments of plasma progesterone concentrations demonstrated a short to medium period of anestrus in the months of September through December. Sasa et al. (2002) reported that other factors, such as nutrition and age, influence reproductive seasonality. In the present study, there was no change in the BCS throughout the year, and the animals' ages were similar. Thus, it is possible that some Santa Inês ewes show a degree of sensitivity to the photoperiod that is reflected in reproductive seasonality at the latitude studied, even in brief periods of time. Moura et al. (2014), studying Santa Inês ewes at a latitude of 1° 12' south, did not find a difference between expression of estrus and pregnancy rates in the dry and wet months in northern Brazil. Coelho et al. (2006) based on a research conducted at a latitude of 21° 59' south, reported short-spaced periods of anestrus between October and January in the same breed. Furthermore, Moraes et al. (2013), based on study performed at a latitude of 23° 25' south, reported an absence of estrus in this breed from the months of October to December. Therefore, these studies have shown that with increasing latitude, there is a

tendency in Santa Inês ewes to express degrees of reproductive seasonality that are more pronounced.

Social relations also play an important role in the regulation of reproductive seasonality in sheep (Perkins and Fitzgerald 1994). However, the ewes were not maintained in proximity to a ram. The female effect, already discussed by O'Callaghan et al. (1994), may be related to biostimulation and cyclical return in December in 100 % of the females evaluated.

In a recent study, Sasa et al. (2011), at a similar latitude of 21° 59' south in the spring season, showed that only the presence of a ram (male effect) and the nutrition increase (flushing effect) were required to establish cyclicity in all Santa Inês ewes that were evaluated. Thus, the combination of management techniques, without hormone therapy, may be critical to creating more green, clean, and ethical products, with higher added values. To achieve this goal, more research is needed that focuses on these techniques in commercial flocks and on information regarding the available agricultural conditions for food supply of each region.

Conclusion

The Santa Inês ewes, in this study, showed a low degree of reproductive seasonality. Some of the ewes had a seasonal anestrus during the spring. Thus, it is possible that some Santa Inês sheep exhibit some degree of sensitivity to the photoperiod and undergo anestrus, even with controlled nutritional conditions. Further studies with a combination of management techniques are needed to improve reproductive efficiency without hormone therapy, in this breed, under tropical conditions.

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Conflict of interest The authors declare that they have no conflict of interest.

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