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Short communication

The timing of the commencement of the breeding season in Boer and rangeland goats raised in the tropics of Queensland, Australia

D.M. Nogueira [a,b,*], J. Cavalieri [b], B. Gummow [b,c], A.J. Parker [b]

[a] Embrapa Semiárido, BR 428, Km 152, Caixa Postal 23, CEP 56302-970. Petrolina, PE, Brazil
[b] College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, QLD 4811, Australia
[c] Faculty of Veterinary Science, University of Pretoria, Pretoria, South Africa

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ABSTRACT

This study aimed to determine the timing of the onset of the breeding season in Boer and rangeland goats raised in a tropical region of northern Queensland. The experiment was carried out using 25 Boer and 20 rangeland female goats. Boer and rangeland goats were kept on the same pasture in the absence of males and supplemented to provide nutritional requirements above maintenance. Blood samples were collected once weekly from December 2011 to May 2012 and analyzed for concentrations of progesterone. The mean time to first ovulation was found to occur earlier in Boer compared to rangeland goats (64.7 ± 5.0 days vs. 87.7 ± 5.6 days, respectively; $P < 0.05$). Differences in survival curves ($P < 0.05$) for the timing of onset of first ovulation between breeds were also detected. Boer goats started ovulating in December (8.3%) and had all ovulated by March while most rangeland goats started ovulating in March (84%) and had all ovulated by the end of April. These results demonstrate that in a tropical region of north Queensland Boer goats commence ovulatory cycles earlier than rangeland goats which may be beneficial if an earlier start to the breeding season is preferred.

1. Introduction

In Australia there are approximately 4.5 million goats (FAO, 2013), comprising 4.1 million rangeland goats and 400,000 domestically farmed goats (Pople and Froese, 2012). Thus rangeland goats represent more than 90% of goats thought to be present in Australia. Australia is the largest exporter of goat meat worldwide, slaughtering more than 2 million goats and producing 31,700 tonnes of meat in 2013–2014 (McRae and Thomas, 2014). While goat meat exports from Australia commenced in 1952 (Restall et al., 1982), the Australian goat industry remains relatively small and little is known about the production and reproduction of goats raised within tropical regions of Queensland, in which 12% of the goat population in Australia is estimated to be located (Pople and Froese, 2012).

A seasonal distribution in breeding activity is common of sheep and goats living outside the tropics. In subtropical and temperate areas, the breeding season is stimulated by a reduction in the hours of daylight (negative photoperiod), with the largest percentage of conceptions occurring in autumn and winter (Fatet et al., 2011). However, in tropical areas, such as northern parts of Queensland where

* Corresponding author at: Embrapa Semiárido, BR 428, Km 152, Caixa Postal 23, CEP 56302-970. Petrolina, PE, Brazil. Tel.: +55(87)3866 3600.
E-mail addresses: daniel.nogueira@embrapa.br, daniel.maianogueira@my.jcu.edu.au (D.M. Nogueira).

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fluctuations in day length are not as extreme as in more southern parts of Australia (Timeanddate, 2014), it is often hypothesized that food availability is the main factor controlling annual sexual activity within sheep and goats maintained in tropical environments (Mellado et al., 1991; Scaramuzzi and Martin, 2008). At present, there is no information available about the timing of the commencement of the breeding season in Boer and rangeland goats raised in the tropics of Queensland. Determining the onset of the breeding season is critical when determining optimal times for commencement of breeding programmes in extensively managed goat herds.

Boer goats are regarded as very adaptable under all environmental conditions of Southern Africa, including Mediterranean, tropical and subtropical and semi-desert regions (Casey and Van Niekerk, 1988; Greyling, 2000). Rangeland goats in Australia are descended from the first European settlements and subsequent introductions. These goats were commonly kept by householders as a source of milk and were used as draught animals, some of which established permanent populations within sparsely populated areas of Australia (Restall et al., 1982). Rangeland goats can survive long dry periods, in areas where average annual rainfall ranges from 150 mm to 450 mm and temperatures exceed 40 °C in summer (Restall et al., 1982; Thompson et al., 2002). Rangeland goats have therefore adapted over the past 200 years in Australia to the prevailing climatic conditions which could have altered their annual reproductive cycle in comparison to other breeds of goats and fostered natural selection for survival rather than reproductive traits.

Knowledge of the timing of the commencement of the breeding season in Boer and rangeland goats raised within northern Queensland will provide information on when interventions, such as strategic nutritional supplementation and/or hormonal treatments should be applied. The aim of this study was, therefore, to determine the timing of the onset of the breeding season in Boer and rangeland goats raised in the tropics of Queensland, Australia.

2. Material and methods

2.1. Location, animals and evaluation period

This experiment was carried out at James Cook University, Townsville (19°19′30″ S; 146°45′44″ E) which is located within a tropical region in Queensland. The experiment was conducted between December 2011 and May 2012, during what was estimated to be the transition from the non-breeding season to the breeding season for goats. A total of 25 Boer and 20 rangeland nulliparous, anoestrous does, were enrolled in the study. In November, every goat was classified as being in anoestrous when no corpora lutea were observed in the ovaries when examined twice 14 days apart using transrectal ultrasonography. At the start of the experiment, the mean (±SEM) age and body weights of the does were 1.5 ± 0.1 years and 43.8 ± 0.9 kg for Boer goats, and 1.4 ± 0.2 years and 35.6 ± 1.0 kg for rangeland goats, respectively. Experimental procedures for the study were approved by the James Cook University Animal Ethics Committee (approval number: A1695).

2.2. Animal management

Female Boer and rangeland goats were maintained on the same pasture in the absence of male goats. Does were supplemented daily with a base ration consisting of lucerne hay and had ad libitum access to a pasture of annual ryegrass (*Lolium multiflorum*) in order to provide nutritional requirements above maintenance (7.6 MJ ME/day) for a goat weighing 40 kg (NRC, 2007). The body weights of all animals were monitored every two weeks from November 2011 to May 2012.

2.3. Blood samples and progesterone assays

Blood samples were collected once weekly (weeks 0–18) from the jugular vein using evacuated tubes (BD Vacutainer®, Plymouth, UK) containing lithium heparin. Samples were stored on ice then centrifuged (2500 × *g* for 15 min) within 2 h of collection. Plasma was then isolated and frozen (−20 °C) until the time of assay. The onset of the breeding season was recorded when concentrations of progesterone were determined to be greater than 1 ng/mL in two successive blood samples collected one week apart. The mean time to first ovulation was defined as the interval between the day that goats were first classified as being in anoestrus (Day 0) and the first day when concentration of progesterone exceeded 1 ng/mL (Thimonier, 2000).

Concentrations of progesterone in plasma were measured using a competitive binding enzyme-linked immunosorbent assay (Access Progesterone 33550, Beckman Coulter Australia Pty Ltd, Lane Cove, NSW). The sensitivity of the assay was 0.10 ng/mL. The intra-assay coefficients of variation for low (0.62 ng/mL) and high (5.81 ng/mL) controls were 9.5% and 6.8%, respectively. The corresponding inter-assay coefficients of variation were 17.3% and 14.5%. The ratios for observed/expected values for dilution parallelism using the ELISA assay were assessed using nine serial dilutions of three plasma samples collected from goats in which a CL was observed between days 12 and 15 of oestrous cycle. The average (mean ± SEM) of the observed/expected ratios (efficacy) was 110 ± 2.6%.

2.4. Statistical analyses

Statistical analyses were conducted using the statistical software package IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, 2013). Repeated measures analysis of variance was used to compare the variation in body weight between Boer and rangeland goats. The distribution of the timing of the first ovulation (P4 > 1 ng/mL) between breeds was determined with the log-rank test (Mantel–Cox), using Kaplan–Meier survival curves. A multivariate Cox proportional model was used to analyze the effect of the initial body weight, breed and their interaction on the interval to first ovulation. In addition, ANOVA was used to determine the difference in the mean interval in days to the first ovulation between breeds and Levene's test was used to assess homogeneity of variance in the mean interval to the onset of first ovulation. The proportion of goats ovulating every month was compared with a Chi-square test. Results are presented as mean ± SEM and differences were considered significant when $P < 0.05$.

3. Results

The mean time to first ovulation was significantly less in Boer goats compared to rangeland goats (64.7 ± 5.0 days vs. 87.7 ± 5.6 days, respectively; $P = 0.004$). In addition, the variability for the onset of the first ovulation was greater in Boer goats than in rangeland goats ($P = 0.010$; Fig. 1). Eight percent of Boer goats started ovulating in December, two months before any rangeland goats had started ovulating. Most ovulations in rangeland goats were detected in March (84%) (Fig. 1).

The difference between breeds for the distribution of the timing of the first ovulation was also supported by differences in the Kaplan–Meier survival curves between breeds ($P = 0.038$). The timing of first ovulation in Boer goats occurred gradually over the period of 18 weeks, in contrast to rangeland goats, in which the timing of first ovulation happened suddenly between weeks 10 and 12 (Fig. 2).

Analysis of body weights between the two breeds over time indicated that there were differences between breeds ($P = 0.001$). The mean weights of Boer and rangeland