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Quantifying the effect of seasonality on testicular function of Suffolk ram in lower latitude

Viviane Milczewski[a,1,3], Samira Chahad-Ehlers[a,1], Katherine Maria Spercoski[b,2], Rosana Nogueira Morais[b,2], Vanete Thomaz Soccol[a,*]

[a] Programa de Doutorado em Processos Biotecnológicos e Biotecnologia, Departamento de Engenharia Química, Universidade Federal do Paraná, Centro Politécnico, Jardim das Américas, UFPR, 81 531-990 Curitiba, Paraná, Brazil
[b] Departamento de Fisiologia, Universidade Federal do Paraná, Centro Politécnico, Jardim das Américas, UFPR, 81 531-990 Curitiba, Paraná, Brazil

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ABSTRACT

Suffolk breed is known to display a clear seasonal reproductive response orchestrated by the significant annual variation in photoperiod related to its latitude of origin. However, in the low latitudes of the tropical and subtropical environments the magnitude and timing of these responses in Suffolk rams has been poorly investigated. This study aimed to quantify changes on andrological parameters in Suffolk rams kept under natural light/dark cycle and climate in the south of Brazil (25°25′40″ S, 49°16′23″ W). Rams were monitored during 1 year for testicular size, seminal parameters and serum testosterone. From autumn to winter, under shortening daylength, rams underwent a significant gonadal involution. Testicular size increased in spring and reached a peak in summer, similar to the latitude of which this breed originates. Parallel to scrotal circumference, other parameters such as testicular volume, serum testosterone concentration, ejaculate volume and sperm concentration followed a seasonal profile. Testosterone levels followed the same seasonal pattern as testicular size. Ejaculate volume was significantly lower during autumn and winter and higher values of sperm concentration were detected in spring. Furthermore, there were no significant changes in spermatozoa defects, motility, weave motion or vigor between seasons. In this paper we analyze the impact of seasonality over testis function in Suffolk rams at lower latitudes.

* Corresponding author at: Programa de Doutorado em Processos Biotecnológicos e Biotecnologia, Departamento de Engenharia Química, Universidade Federal do Paraná, Centro Politécnico, Jardim das Américas, UFPR, 81 531-990 Curitiba, Paraná, Brazil. Tel.: +55 41 3361 3272; fax: +55 41 3361 3272.
E-mail addresses: viviane.milczewski@ifc-araquari.edu.br (V. Milczewski), schahad@gmail.com (S. Chahad-Ehlers), kethymaria@yahoo.com.br (K.M. Spercoski), moraisrn@ufpr.br (R.N. Morais), vasoccol@ufpr.br (V. Thomaz Soccol).
[1] Tel.: +55 41 3361 3272; fax: +55 41 3361 3272.
[2] Tel.: +55 41 3361 1719; fax: +55 41 3266 2042.
[3] Present address: Instituto Federal de Educação, Ciência e Tecnologia Catarinense – campus Araquari, Rodovia BR 280, Km 27, Caixa Postal 21, 89245-000 Araquari, Santa Catarina, Brazil. Tel.: +55 47 3803 7257; fax: +55 47 3803 7201.

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1. Introduction

The gonadal activity cycle is a well documented event in many breeds of sheep reared under controlled photoperiod (Boland et al., 1985; Jackson et al., 1990; Gómez-Brunet et al., 2008) and at high latitudes (Lincoln et al., 1990; Mandiki et al., 1998a,b; Dickson and Sanford, 2005; Gündogan, 2007; Sarlós et al., 2013). Ample evidences already exist in the literature to support that gonadal function of high-latitude rams is regulated by changes in the daylength throughout a synchronization process involving the circadian system (Howles et al., 1982; Bartness et al., 1993; Goldman, 2001; Lincoln et al., 2006) which drives the melatonin-production and leads to the annual restriction of reproduction (Arendt et al., 1988). These findings are even extended to molecular levels utilizing seasonal reversible fertility of the Syrian hamster as a model in which a range of genes involved in turning off sperm production were discovered (Maywood et al., 2009). Moreover, the sensitivity to photoperiodic signals or the way these signals are conveyed to generate seasonal reproductive changes in sheep appears to be different among breeds. Such difference is associated with genetic characteristics related to the latitude of origin (Lincoln et al., 1990; Coelho et al., 2006; Gómez-Brunet et al., 2008). It means that the response pathway is altered for melatonin that acts within target tissues, such as pars tuberalis of pituitary gland and mediobasal hypothalamus, to affect the seasonal regulation of prolactin and gonadotrophins secretion. In turn, these hormones are involved in the seasonal control of lactotrophic/metabolic and reproductive alterations (Lincoln et al., 2003). Seasonal changes in hormonal levels function as key regulators for spermatogenesis as well as for the testicular mass and size in rams. Short after summer solstice, both testicular size and testosterone secretion reach maximum peak and are followed by peripheral responses such as sexual and aggressive behavior (Lincoln and Davidson, 1977).

Testes size, usually measured as scrotal circumference (SC), is a very important parameter to evaluate breeding soundness in sheep (Chemineau and Cognié, 1991). Thus, the difference between the maximum and minimum size during an annual reproductive cycle can be used as a parameter to estimate the degree of seasonal variation for different breeds (Lincoln, 1989). Since SC is an indicator of the ram's potential fertility, the minimum recommended is used to classify and even to eliminate an animal in breeding programs (Bagley, 1997; Seaman, 2004).

Informations about the effects on gonadal function, when a high-latitude breed sheep is translocated into regions of lower latitudes, are very limited especially in males. Martin and coauthors (1994) emphasized the importance of photoperiod on male fertility. They also drew attention to the lack of publications in latitudes such as those between 35° N and 35° S where the world's largest populations of sheep are concentrated. Gastel et al. (1995) and Bielli et al. (1999) evaluated a Merino–Lincoln cross, the Corriedale breed, in Uruguay (32° S) and found moderate seasonal changes on morphology and function of testicles. Hötzel et al. (2003) studied rams of 'mediterranean origin' (Merino) and 'temperate origin' (Suffolk) in Australia (32° S) and showed that photoperiod is the main determinant of seasonality in Suffolk, whereas in Merino the nutrition overrides the effect of seasonality.

In the subtropical regions of Brazil, the most reliable information about seasonal reproduction registered nearest to the region of the present study (25° S) was performed in the North of the same State (23° S). The authors evidenced seasonal responses in the fertility of black-faced ewes of 'temperate origin' (Hampshire Down), showing that most of births (73.9%) occurred in winter and spring (Ribeiro et al., 1996). The work suggests that most females were fertilized in summer and autumn. Considering that males approximately follow the synchronicity of females' oestrus (Thibault et al., 1966; Emlen and Oring, 1977), these annual changes may be also perceptive in males of same breed, exhibiting similar breeding activity. Thus, in order to reduce the existing gap of information about the latitudinal effect on seasonal breeds subjected to lower latitudes of the southern hemisphere, the present study aimed to evaluate the gonadal function of Suffolk rams kept in a subtropical region (25° S) of Brazil. For this purpose, the magnitude of variation on testicular size, serum testosterone and andrological features were evaluated along 1 year using Suffolk rams kept under intensive system and natural photoperiod.

2. Materials and methods

2.1. Location and animals

The experiment was carried out from April to March, over a 12 months period, at the Cangüiri Experimental Farm of the Federal University of Paraná, located at Pinhais-PR, south of Brazil (25°25′40″ S, 49°16′23″ W; altitude 893 m). Local amplitude of photophase throughout the year varies from 13 h44′ (10 h16′ of dark) in the summer solstice to 10 h33′ (13 h27′ of dark) in the winter solstice, i.e., 3h11′ of difference between the longest and the shortest day of the year. Climate of the region is classified as Cfb following Köppen Climate Classification System (Peel et al., 2007), with no distinct dry season, summer and winter well defined and annual variation temperatures from 3 to 18 °C in coldest months and below 22 °C in warmest months. The average monthly temperatures were provided along the experiment by the local meteorological station from the Experimental Farm and included in the study.

Experiments were carried out strictly in accordance with the Ethics Committee of the Federal University of Paraná. A total of 12 purebred Suffolk rams 10–13 months old, weighing around 51.5 ±8.5 kg at the beginning of the experiment with no previous sexual experience were kept under intensive rearing conditions on natural light/dark cycle and climate. They were fed a balanced diet based on corn silage and grain mixture, mineralized salt and water for *ad libitum* intake. Health conditions were constantly monitored, because of verminosis, by evaluating corporal condition and the degree of anemic state (FAMACHA© method; Bath et al., 2001). In parallel, an older purebred Suffolk rams group (about 4 years old, $n = 3$) weighing around 98 kg was evaluated (SC and body mass) under the same described condition. This evaluation extended for two more months compared to the study group (see Fig. S1).

Supplementary Fig. S1 related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.smallrumres.2014.12.012.

2.2. Experimental design

At each 15-day interval, rams were weighed and scrotal circumference (SC) was measured with a flexible tape at the widest circumference without pressing down the testes. In parallel to SC, the testicular volume was estimated by measuring width and length of testes with calipers, excluding epididymis. To calculate the testicular volume, a basic ellipsoid