Changes in sexual behaviour and semen quality associated with age and type of enclosure of Saint Croix rams in different seasons of the year

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Abstract

The objective of this study was to evaluate sexual behaviour and semen quality of St. Croix ram lambs bred in a semi-desert region. In Experiment 1, 24 yearling rams were assigned to two groups: T1 with 12 males confined for 11 months; T2 with 12 males confined individually for the same period of time. In Experiment 2, 20 four-month-old ram lambs were assigned to two groups of 10 animals each. In each experiment, sexual behaviour and semen quality were evaluated every 2 weeks over 11 months. In Experiment 1, rams that were individually confined showed better sexual activity than lambs confined together (P<0.05), whereas in Experiment 2 ram lambs confined individually only showed shorter time to first mount with ejaculation (P<0.05). In experiment 1, sperm with better progressive motility (P<0.05) was recorded per yearling ram confined individually (63.4±0.2%) in comparison with rams confined together (51.60.1%). In Experiment 2, ram lambs confined together showed better semen quality (P<0.05). In both trials, an effect of the season was observed on both sexual behaviour and semen quality (P<0.05). In conclusion, this study of St. Croix males showed different sexual behaviours according to age and type of enclosure.

Introduction

Development of hair breeds, such as the Saint Croix in Mexico, can be an interesting alternative for increasing the efficiency of lamb meat production systems. Photoperiod (Delgadillo et al., 2009), availability of food supplements during critical seasons (Scaramuzzi et al., 2006) and low forage production in semi-arid regions due to climatic conditions (Sánchez-Dávila et al., 2011) play an important role in the productivity of the various species. Consequently, efficient reproduction in males should be enhanced through an adequate understanding of environmental factors, such as climate, nutrition and health, since they influence male fertility in different seasons of the year and under different reproductive management methods, such as continuous or controlled breeding (Stellflug et al., 2008; Ridler et al., 2012). It has been reported that seasonality of hair sheep is not as marked as in wool breeds (Godfrey, 2005; Valencia and Ledezma, 2005; Valencia et al., 2006; Uthlaut et al., 2011). In summer, a decrease in semen quality (Martín et al., 2004; Ridler et al., 2012), scrotal circumference, testicular weight, and sexual behaviour is observed in wool rams living in latitudes higher than 40° (Ungerfeld et al., 2007). Their sexual behaviour is completely inhibited due to the lack of gonadotropin hormone support (Ungerfeld et al., 2007; Sanford and Dickson, 2008), thus affecting the capacity to induce oestrus in ewes (Stellflug et al., 2006). In hair sheep, natural breeding is carried out throughout the year. The rams used in this study exhibited acceptable libido and sexual behaviour under different temperature and environmental conditions all year round (Sánchez-Dávila et al., 2011; Ridler et al., 2012). Consequently, it is necessary that rams show an effective sexual activity according to age and the relationship between their breeding capacity and sexual orientation, because this translates into high conception and lambing rates throughout the breeding year (Stellflug et al., 2006; Ridler et al., 2012; Sánchez-Dávila et al., 2012). In general, fertility is higher and more efficient when ewes are exposed to rams that exhibit better sexual behaviour, leading to higher conception rates in comparison with ewes exposed to ram lambs (4-6 months) exhibiting poor sexual behaviour and variable semen quality (Stellflug and Lewis, 2007; Ungerfeld et al., 2008; Alexander et al., 2012). In recent studies, St. Croix sheep rams have been used to stimulate oestrus in Suffolk anoestrous ewes synchronized out-of-season (Orihuela and Aguirre, 2011). Another aspect to be considered is that in sheep herds the batch of rams is commonly kept in a single pen, therefore affecting their sexual behaviour and semen quality since their early age, because of the interactions they entertain between one another (Stellflug and Lewis, 2007; Alexander et al., 2012). Consequently, the aim of this study was to evaluate sexual behaviour and semen quality of hair sheep rams at different ages kept under enclosure conditions in different breeding seasons.

Materials and methods

Location

This study was conducted at the Laboratory of Animal Reproduction, Campus Marín, of the Agronomy Department of the Autonomous University of Nuevo León, General Escobedo, Nuevo León, Mexico. Tel. +52.81.13404399 - Fax: +52.81.83974588. E-mail: fernando_sd30@hotmail.com

Key words: Sexual behaviour; Semen quality; Rams; Lambs; Season of the year.

Conflict of interest: the authors declare no potential conflict of interest.

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Legal statement of the experiment: animal welfare standards of sheep owned by the Agronomy Department of the Autonomous University of Nuevo León are in full compliance with the Mexican Official STANDARD NOM-062-ZOO-1999.

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Autónoma de Nuevo León; located in Marín, Nuevo León, Mexico, at 25° 50’ 34” N latitude and 100° 04’ 21” W longitude and at an altitude of 333 m above sea level.

Experiment 1

Animals

This study was carried out from July 2012 to August 2013 on 24 St. Croix hair sheep rams. At the beginning of the experiment the average age was 12±1.7 months, the live weight (LW) was 35.1±3.7 kg and the body condition (BC) (Arranz, 2002) was 3.5±0.1. At the end of the experiment, the rams were 23±1.2 months old and had reached a body weight of 52.8±4.3 kg and a BC of 2.7±0.1 (Arranz, 2002).

Management

Rams were fed twice a day ad libitum a ration with 14% crude protein and 2.2 Mcal metabolizable energy/kg. Rams came from single lambing and were kept together in an enclosure for 2 months before the study began. Subsequently they were split into 2 groups based on their initial weight, as follows: T1-12 rams in permanent contact for 11 months in an 18-square-meter pen; T2-12 rams in individual 2-square-meter cages for the same period of time.

The animal welfare standards under which sheep owned by the Agronomy Department of the Universidad Autónoma de Nuevo León were kept were in full compliance with the Mexican Official STANDAR NOM-062-ZOO-1999. Social hierarchy was not evaluated for males kept together. The 2 groups of males were kept 50 m apart, where they could see each other.

Sexual behaviour

Every 2 weeks over the experimental period, sexual behaviour was evaluated using 2 oestrogrenised ewes, to which 1 mg of estradiol benzoate was administered (Syntex®, Buenos Aires, Argentina) for 2 days, prior to the evaluation of sexual behaviour (Sánchez-Dávila et al., 2012). The ewes were changed each month and rams were individually exposed to a ewe for a period of 20 minutes in order to evaluate the following variables: courtship latency (LCI), number of lateral approaches (NLA), number of sniffs (NS), flehmen (F), mount attempts (MA), number of mounts (NM), number of mounts with ejaculation (NME), time interval among mounts with ejaculation (TME).

Semen collection and evaluation

Only a single semen sample was obtained from each ram using the electro-ejaculation method every 15 days (Standard Precision Electronics, Denver, CO, USA), the day before sexual behaviour evaluation (Evans and Maxwell, 1990). Semen collection started at 8:00 am, and sample was evaluated immediately. Samples were stored at 37°C. The variables evaluated for semen quality were: volume (VOL), which was directly recorded in the graduated collection glass cup (mL); sperm mass motility (MM, a scale of 0-5), sperm progressive motility (PM, %), and total sperm concentration (SC, conc/mL). In order to evaluate sperm progressive motility, semen was diluted (1:200) in a saline solution using a red blood cell diluting pipette, and cell counting was measured in a Neubauer improved chamber using 400X magnification (Palma, 2001) under a phase contrast microscope (Primo Star; Zeiss, Minutube America, WI, USA). For pH measurement, a drop of semen was spread evenly on a pH paper (pH-Fix 0-14; Macherey-Nagel, Düren, Germany). Then its colour was compared with the calibration strip. The eosin-nigrosin staining technique was used to determine abnormal sperm morphology (ASM). This stain solution contained 1.67 g of eosin, 10 g of nigrosin, 2.9 g of sodium citrate and 100 mL of water (Faga-Lab, Sinaloa, Mexico). A drop of semen and a drop of stain were placed at one end of a glass slide. Another slide was used to mix the drops and convert the resulting mixture into a thick smear. It was then air dried and examined under a 400X (Primo Star) microscope. A hundred spermatozoa from different fields were observed and the number of normal and abnormal spermatozoa was recorded (Evans and Maxwell, 1990). All analyses were performed by the same operator.

Semen collection and evaluation

Live weight, testicular size

Scrotal circumference (SC) was measured with Coulter scrotal tape (Trueaman, Edmonton, KY, USA) and live weight (LW) of each ram was recorded every 15 days.

Experiment 2

This study was carried out from March 2013 to March 2014. Twenty St. Croix hair sheep rams with an initial average age of 4±0.7 months were used. They had an average LW of 20.1±4.3 kg and a BC of 2.8±0.1. At the end of the experiment they reached a LW of 38.3±4.4 kg and a BC of 2.5±0.1. Rams belonged to a single flock, were born in the same season of the year (winter) and each one came from a single lambing. After weaning at 3 months of age, they were immediately separated. An adaptation period of 1 month was allowed in order to avoid the effect of the ewe maternal behaviour. In this experiment, lambs were fed a concentrate, containing 17% crude protein and 2.2 Mcal metabolisable energy/kg. Beyond 25 kg live weight, they were provided with concentrate containing 16% of crude protein and 2.4 Mcal Metabolizable Energy/kg, until the end of the experiment. The animals were split into 2 groups of 10 based on their initial live weight. The animals belonging to one group (Treatment 1) were distributed in individual cages, whereas the other group (Treatment 2) was kept in a single pen. The evaluations of sexual behaviour, semen quality, live weight and testicular size were carried out as described for Experiment 1. Beginning on date of first ejaculation, semen characteristics and sexual activity was evaluated, every 2 weeks through one year.

Table 1. Effect of enclosure type on sexual behaviour characteristics during the year of the study, in 1-year-old St. Croix hair sheep rams.

| Variable                      | Observations, n | Individual | Group |
|-------------------------------|-----------------|------------|-------|
| Animals, n                    | 288             | 12         | 12    |
| Live weight, kg               | 51.2±2.0        | 54.5±2.1   |       |
| Scrotal circumference, cm     | 32.2±0.2        | 31.5±0.2   |       |
| Courtship latency, sec        | 6.1±5.2         | 13.2±6.1   |       |
| Lateral approaches            | 19.1±0.1        | 10.0±0.1   |       |
| Sniffing                      | 8.1±0.1         | 9.9±0.1    |       |
| Flehmen                       | 4.1±0.1         | 7.1±0.1    |       |
| Mount attempts                | 1.6±0.2         | 2.1±0.2    |       |
| Mounts                        | 4.9±0.4         | 4.2±0.4    |       |
| Mounts with ejaculation        | 8.2±0.1         | 6.0±0.1    |       |
| Time to first mount/ejaculation, sec | 126.2±15.0     | 176.8±14.8 |       |

Values are expressed as mean±standard error of mean. *Means with different letters in the same row indicate difference among type of enclosure (P<0.05).
Statistical analysis

Data were expressed as means (±SEM) and analysed using the SPSS Software (SPSS, 2003) according to a linear model to evaluate the effect of the type of enclosure and the season on semen and sexual behaviour characteristics. When differences between variables were identified, they were compared using Tukey’s test (Steel and Torrie, 1980).

Results



Experiment 1

Table 1 reports the results for sexual behaviour. One-year-old rams in different enclosures showed differences in courtship latency, lateral approaches, Flehmen, mounts with ejaculation and time interval between first mount with ejaculation (P<0.05). Individually-confined rams showed better sexual activity compared with rams grouped together. Table 2 reports the values obtained for semen quality, where an effect of the enclosure type was observed on progressive motility in 1-year-old rams. Values were better (P<0.05) for rams individually confined (63.4±0.2%), in comparison to those confined together (51.6±1.1%).

Table 3 shows better sexual behaviour of 1-year-old rams in autumn and winter, whereas, in spring, their sexual activity was lower (P<0.05). Likewise, there was a seasonal effect on scrotal circumference with the highest values in summer and winter and the lowest in spring (P<0.05). Table 3 shows that during spring and autumn total sperm concentration was higher (P<0.05). As to the percentage of abnormal sperm morphology, it was higher in winter and lower in autumn (P<0.05).

Experiment 2

The average age of Saint Croix at first ejaculation with semen characteristics and sexual behaviour was 178±3.81 days and 116.2±7.2 days respectively. Considering the type of enclosure, young ram lambs, weaned at 4 months of age, individually confined, showed shorter (P<0.05) interval in the time to first mount with ejaculation (49.5±11.8 sec; Table 4), than those confined together (68.4±11.9 sec). Ram lambs weaned at four months and kept together (Table 5) showed better semen quality (P<0.05) in terms of sperm mass motility (1.5±0.3), progressive motility (17.6±2.3%) and total sperm concentration (51.2±7.3×10⁶/mL).

Table 6 shows the results obtained by young lamb rams weaned at 4 months with sexual behaviour characteristics according to season, with values being higher (P<0.05) in autumn and winter and lower in spring, when the study started. semen quality characteristics showed differences (P<0.05) among seasons, with better semen quality being reported in autumn and winter, in terms of percentage of progressive motility, total sperm concentration and abnormal sperm morphology.

Discussion

Experiment 1

One-year-old rams individually confined showed better courtship latency (61±5.2 sec), mounts with ejaculation (8.2±0.1) and time to first mount/ejaculation (126.2±15.0 sec), in comparison with those grouped together. This may be attributed to the fact that individually confined animals did not experience any competition and were able to present rapid initiative of courtship. Therefore, more mounts with ejaculation occurred in individual confined rams than in those ones confined together (Kridli et al., 2008). However, rams confined together developed a social hierarchy.

Table 2. Effect of enclosure type on semen quality during the year of the study, in 1-year-old St. Croix hair sheep rams.

| Variable                      | Observations, n | Individual | Group |
|-------------------------------|-----------------|------------|-------|
| Rams, n                       | 12              | 12         |       |
| Volume, mL                   | 288             | 1.1±0.1    | 1.2±0.2 |
| Mass sperm motility, %        | 288             | 2.7±0.1    | 2.5±0.2 |
| Progressive motility, %       | 288             | 63.4±0.2   | 51.6±1.1 |
| Total sperm concentration, mL | 288             | 457.4±10.1 | 461.3±9.8 |
| Semen pH                      | 288             | 6.7±0.3    | 7.4±0.3 |
| Abnormal sperm morphology, %  | 288             | 1.4±0.2    | 1.6±1.1 |

Values are expressed as mean±standard error of mean. a-cMeans with different letters in the same row indicate difference among type of enclosure (P<0.05).

Table 3. Effect of the season of the year on sexual behaviour characteristics and semen quality in 1-year-old St. Croix rams.

| Dependent variable          | Observations, n | Spring | Summer | Autumn | Winter |
|-----------------------------|-----------------|--------|--------|--------|--------|
| Live weight, kg             | 72              | 52.2±2.0 | 54.5±2.1 | 49.3±0.6 | 48.3±0.7 |
| Scrotal circumference, cm   | 72              | 30.9±0.2 | 32.3±0.2 | 30.5±0.2 | 31.0±0.2 |
| Courtship latency, sec      | 72              | 19.8±3.3 | 14.6±2.8 | 7.4±3.3 | 3.5±3.1 |
| Lateral approaches          | 72              | 10.4±0.3 | 11.6±0.4 | 36.1±4.0 | 42.4±4.0 |
| Sniffing                    | 72              | 4.2±0.1  | 6.1±0.1 | 12.7±1.0 | 13.0±1.0 |
| Flehmen                     | 72              | 8.2±0.1  | 7.0±0.2 | 4.1±0.2 | 3.4±0.2 |
| Mount attempts              | 72              | 5.8±0.1  | 6.1±0.1 | 16.0±1.0 | 16.5±1.0 |
| Mounts with ejaculation      | 72              | 2.5±0.1  | 4.0±0.1 | 5.3±1.0 | 4.3±1.0 |
| Time to first mount/ejaculation, sec | 72          | 73.7±21.9 | 165.8±18.1 | 157.7±21.9 | 236.3±20.2 |
| Volume, mL                  | 72              | 1.2±0.1  | 1.4±0.1 | 0.8±0.1 | 1.2±0.1 |
| Sperm motility, %            | 72              | 2.4±0.1  | 2.3±0.1 | 3.0±0.1 | 2.7±0.1 |
| Progressive motility, %      | 72              | 69.8±2.0 | 73.5±2.0 | 50.7±0.2 | 64.1±0.2 |
| Total sperm concentration, mL | 72              | 475.9±3.6 | 493.5±14.9 | 404.1±15.6 | 463.9±14.0 |
| Semen pH                     | 72              | 7.2±0.3  | 7.2±0.4 | 6.8±0.4 | 7.9±0.4 |
| Abnormal sperm morphology, % | 72              | 1.6±0.0  | 1.3±0.1 | 1.0±0.0 | 2.1±0.2 |

Values are expressed as mean±standard error of mean. a-cMeans with different letters in the same row indicate difference among type of enclosure (P<0.05).
Although this aspect was not evaluated, studies of animals belonging to the same breed conducted by Aguirre et al. (2007) showed that, when males are grouped together, an effect of social hierarchy (dominant or subordinate) may be experienced by the animals, thus causing further stress. Semen quality and testosterone levels are therefore affected along with sexual behaviour. In our study, our 1-year-old rams had not reached their full reproductive potential and therefore they did not exhibit an adequate sexual behaviour (frequency of mounts and ejaculation). Age of the ram should be taken into account, since studies evaluating 2 and 3-year-old hair and wool rams demonstrated that they have a better sexual behaviour and can induce the oestrous in a greater percentage of acyclic wool ewes, than in individually confined ram lambs (Ensen, 2005; Simintzi et al., 2006; Kridli et al., 2008; Ungerfeld et al., 2008; Egerszegi et al., 2014).

Ram lambs confined together showed better semen quality in terms of sperm motility, progressive motility and total sperm concentration. These results suggest that group penned ram lambs interacting with their pen mates initiate spermatogenesis at an earlier age, than in individually confined ram lambs (Belibassaki and Kouimtzis, 2000). Also Ungerfeld and Lacuesta (2010) reported that spermatogenesis did not develop efficiently in individually confined ram lambs compared with group confined lambs exposed to a ewe in oestrous. Other studies (Price et al., 1999; Orihuela, 2014) demonstrated that the heterosexual experience in this breed contributes to stimulate spermatogenesis already at an early age.

Table 4. Effect of enclosure type on sexual behaviour characteristics during the year of the study, in St. Croix hair sheep ram lambs weaned at 4 months.

| Variable                          | Observations, n | Individual | Group |
|-----------------------------------|-----------------|------------|-------|
| Animals, n                        | 10              | 10         |       |
| Live weight, kg                   | 240             | 30.0±0.6   | 28.3±0.6 |
| Scrotal circumference, cm         | 240             | 23.7±0.4   | 24.2±0.4 |
| Courtship latency, sec            | 240             | 27.5±7.2   | 20.3±7.2 |
| Lateral approaches                | 240             | 2.3±0.5    | 2.2±0.5 |
| Sniffing                          | 240             | 5.4±0.8    | 5.1±0.4 |
| Flehmen                           | 240             | 1.5±0.2    | 1.4±0.2 |
| Mount attempts                    | 240             | 2.8±0.5    | 3.1±0.5 |
| Mounts                            | 240             | 2.9±0.4    | 1.7±0.4 |
| Mounts with ejaculation            | 240             | 4.0±0.7    | 2.8±0.6 |
| Time to first mount/ejaculation, sec | 240 | 49.5±11.8  | 68.4±11.9 |

Values are expressed as mean±standard error of mean. a,bMeans with different letters in the same row indicate difference among type of enclosure (P<0.05).

Table 5. Effect of enclosure type on semen quality during the year of the study, in St. Croix hair sheep ram lambs weaned at 4 months.

| Variable                          | Observations, n | Individual | Group |
|-----------------------------------|-----------------|------------|-------|
| Rams, n                           | 10              | 10         |       |
| Volume, mL                        | 240             | 0.7±0.4    | 0.5±0.4 |
| Mass sperm motility, %             | 240             | 0.4±0.3    | 1.5±0.3 |
| Progressive motility, %            | 240             | 8.3±2.3    | 17.6±2.3 |
| Total sperm concentration, mL (×10^6) | 240 | 27.1±7.2 | 51.2±7.3 |
| Semen pH                           | 240             | 7.1±0.2    | 7.5±0.2 |
| Abnormal sperm morphology, %       | 240             | 3.1±0.1    | 5.4±0.1 |

Values are expressed as mean±standard error of mean. a,bMeans with different letters in the same row indicate difference among type of enclosure (P<0.05).

Table 6. Effect of the season of the year on sexual behaviour and semen quality in St. Croix ram lambs weaned at 4 months.

| Dependent variable                  | Observations, n | Spring | Summer | Autumn | Winter |
|-------------------------------------|-----------------|--------|--------|--------|--------|
| Live weight, kg                     | 60              | 20.2±2.9 | 24.5±2.1 | 29.2±2.3 | 33.2±3.3 |
| Scrotal circumference, cm           | 60              | 22.7±0.2 | 23.5±0.2 | 24.3±0.2 | 25.7±0.2 |
| Courtship latency, sec              | 60              | 29.8±4.3 | 34.6±3.8 | 13.3±3.4 | 23.2±3.4 |
| Lateral approaches                  | 60              | 1.0±0.3  | 1.6±0.4  | 39.1±0.4 | 44.2±0.2 |
| Sniffing                            | 60              | 1.3±1.0  | 2.1±1.0  | 2.7±1.0  | 3.0±1.0 |
| Flehmen                             | 60              | 1.3±1.0  | 1.0±1.0  | 1.1±1.0  | 2.0±1.0 |
| Mount attempts                      | 60              | 1.7±0.1  | 1.1±0.1  | 2.9±1.0  | 3.0±1.0 |
| Mounts with ejaculation              | 60              | 2.6±1.0  | 4.1±2.0  | 5.2±1.0  | 4.6±0.2 |
| Time to first mount/ejaculation, sec | 60             | 33.2±21.3 | 45.8±14.1 | 67.7±18.9 | 66.3±21.2 |
| Volume, mL                          | 60              | 0.7±0.2  | 0.3±0.1  | 0.8±0.1  | 0.6±0.1 |
| Sperm motility                      | 60              | 0.4±0.1  | 0.3±0.1  | 1.0±0.1  | 1.4±0.1 |
| Progressive motility, %             | 60              | 8.7±0.1  | 17.4±0.3  | 10.8±0.1 | 14.1±0.1 |
| Total sperm concentration, mL (×10^6) | 60          | 27.8±2.2 | 19.3±12.8 | 40.1±13.1 | 53.9±12.1 |
| Semen pH                            | 60              | 7.2±0.3  | 7.1±0.3  | 7.0±0.3  | 7.1±0.4 |
| Abnormal sperm morphology, %        | 60              | 4.5±0.0  | 3.3±0.1  | 2.0±0.0  | 2.0±0.1 |

Values are expressed as mean±standard error of mean. a,bMeans with different letters in the same row indicate difference among type of enclosure (P<0.05).
age and can accelerate lamb production or out-of-season breeding.

Analyzing sexual behaviour and semen quality of Saint Croix rams, Aguirre et al. (2007) and Orihuela and Aguirre (2011) reported lower values than those registered in the present study with 12 rams in a group, whereas the study by Aguirre et al. (2007) considered groups of three same-age rams. This plays an important role in the social hierarchy that may be established by ram lambs (Simitzis et al., 2006) and rams (Krdli et al., 2008). Otherwise, Jafariahangari et al. (2012) did not report a post-weaning ram lamb effect on semen quality.

In the present study, 1-year-old rams showed better results in spring and summer in terms of progressive motility percentage and total sperm concentration. However the percentage of abnormal sperm morphology was higher in winter and lower in autumn. These results show that 1-year-old Saint-Croix rams can reach adequate semen quality parameters to start breeding a limited number of females. The percentage of abnormal sperm morphology in autumn could be the result of immature sexual development (Sánchez-Dávila et al., 2012).

Experiment 2

Sexual behaviour in 4-month-old lambs was similar in both groups. Only the time to first mount with ejaculation was shorter in individually confined lambs. According to Krdli et al. (2008) young rams from different breeds, may present a limited sexual activity due to the lack of experience. Sarlós et al. (2013) did not observe effect of dominance on the development of sexual activity in ram lambs raised in a group. However, in this latter group, the evaluations were carried out individually in presence of a ewe in oestrous. Sexual behaviour of the rams was not affected by social hierarchy as reported by Uthlaut et al. (2011). However, Ungerfeld and Lacuesta (2010) reported that ram lambs raised together from pre-puberty on, developed a social hierarchy that affected the sexual behaviour of rams reaching 1.5 years of age. In the present study, the comparison of the results of both experiments (see Tables 1 and 4) showed that 1-year-old rams took longer to complete the first mount with ejaculation than ram lambs, i.e. up to 77.5 in the case of individually confined animals, and 109 in the case of group confined animals.

Four-month-old ram lambs, studied in early spring, showed lower progressive motility and total sperm concentration and higher percentage values of abnormal sperm morphology than in other seasons. This reflects the fact that the sexual parameters can improve when the animals reach an average of 8 months. In summer, in North-Eastern Mexico, temperatures can reach 40°C, yet males are able to perform their sexual activity above the average of other breeds, as well as to mate successfully an allocated group of ewes per ram, especially if mounting is performed at night, a higher breeding rate is achieved and therefore the conception rate is greater (Sánchez-Dávila et al., 2011). It is also interesting to note, that certain sheep breeds, especially Creole and endemic sheep breeds produce good semen quality under severe climate and extreme conditions of vegetation, can also mate successfully an allocated group of ewes (Joshi et al., 2003). In experiment 1 and 2, the sexual behaviour, either in 1-year-old rams or 4-month-old ram lambs, was better in autumn and winter. However, the time to first mount with ejaculation for both age groups of animals was shorter in spring and summer. As a result, although males had better sexual performance in autumn and winter, they had longer latency until the first mount/ejaculation. This could be correlated with the variables of lateral movements and sniffing, as well as mount attempts, which were much greater in autumn and winter, either in 1-year-old rams or 4-month-old ram lambs. These results make this breed even more interesting, showing that it is possible to achieve good reproductive performance in this type of young animals, having therefore a major impact on breeding programmes throughout the year. This confirms that males of this breed can be used already at an early age as an effective aid to induce oestrous in any season of the year in seasonal anoestrous ewes, as reported by Aguirre et al. (2007).

Also scrotal circumference showed no difference either in 1-year-old rams or 4-month-old ram lambs in both enclosures. This could be due to the adequate nutritional conditions for each male group. These differences may be present in case of nutritional imbalances, because the testicular tissue is particularly sensitive to nutritional fluctuations, mainly in energy (Fernández et al., 2004; Maurya et al., 2010). In Experiment 1, season-wise, mean scrotal circumference of 1-year-old rams was the highest in summer compared with the other seasons. In experiment 2, it was observed that ram lambs performed better during winter. Scrotal circumference of rams increased dramatically as the breeding season approached around the beginning of June; these results are equal to the values referred to in the literature for bucks and rams respectively (Delgadillo et al., 2009; Orihuela, 2014).

Conclusions

The results of this study indicate that the management strategy for ram lambs and 1-year-old rams can include the stimulation of sexual activity already at an early age with the aim of achieving healthy semen development and exposing the animals to their first sexual experience one year later. This study demonstrated that hair breeds, particularly St. Croix males, have a different sexual behaviour among seasons of the year, however they are able to stimulate and mate ewes, thus offering the advantage of scheduling lambing throughout the year starting from one year of age. Implementing management and nutritional strategies is helpful to obtain the best results in terms of sexual behaviour and semen quality for ram lambs, according to the season of the year in which they are evaluated.

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