

# Testicular and Seminal Characteristics of Yearling Tazegzawt Rams in Eastern Algeria

Farid Moulla<sup>1</sup>, Mokrane Iguer-Ouada<sup>2</sup>

<sup>1</sup>National Institute for Agronomic Research of Algeria (INRAA), PO Box 200, Hassen Badi 16200, El Harrach, Algiers, Algeria.

<sup>2</sup>Associated Laboratory in Marine and Aquaculture Ecosystems, Faculty of Natural and Life Sciences, Mira University of Bejaia, 06000, Algeria

**Keywords:** Tazegzawt ram, semen quality, testicular measurements, seasonal variations

**Abstract.** This study aimed to evaluate monthly variations in testicular measurements and semen characteristics in young Tazegzawt rams. Ten yearling rams, aged 11 months at the beginning of the experiment, were monitored over a one-year period (January–December). Body weight (BW), scrotal circumference (SC), testis diameter (TD), testis length (TL), semen characteristics and sperm kinematic parameters were recorded monthly.

Significant differences were observed between the months of the year for body weight, testicular measurements and semen parameters ( $P < 0.05$ ), whereas differences across individual rams were significant only for body weight and testicular traits. Testicular size was lowest from January to March and increased progressively from May to November reaching peak values in October and November, followed by a slight decline in December.

Semen volume and sperm concentration were lowest during winter and early spring, increased from late spring to autumn, and reached maximum values in December for semen volume (1.13 mL) and in October–November for sperm concentration ( $\approx 2.2 \times 10^9$  spermatozoa/mL). Sperm motility showed marked seasonal variation, with minimal values in winter and early spring and maximal values ( $\approx 100\%$ ) recorded in September and October. Sperm velocity parameters peaked during late summer and autumn, indicating fast but mostly non-progressive motility.

In conclusion, optimal semen quantity and quality in young Tazegzawt rams were observed from late spring through autumn, whereas reproductive performance declined during winter and early spring. These findings provide valuable information for the conservation and reproductive management of this endangered Algerian sheep breed.

## Introduction

The Tazegzawt sheep are reared mainly for meat production in northeastern Algeria, specifically in the mountain region of Kabylia (Akbou in Bejaia Department), under extensive and often mixed farming systems, together with goat and cattle. The breed is characterized by black spots with bluish reflections on the eyes, ear lobes, muzzle and lower jaw.

Tazegzawt sheep represent a critical Algerian genetic resource and are considered one of the most endangered sheep breeds in the country, with an estimated population of approximately 300 heads. The breed is known for its hardiness, adaptation to mountainous environments, and favourable zootechnical performance, particularly in growth (average birth weight of  $5.0 \pm 1.0$  kg and body weight of  $39.7 \pm 7.0$  kg at 6 months) (Moulla et al., 2022) and reproduction (fertility rate of 84% and prolificacy of 150%) (El Bouyahiaoui et al., 2015). Preservation of the Tazegzawt breed is therefore essential to maintain local adaptability and genetic diversity in Algerian sheep populations.

Reproductive activity in rams is influenced by

several factors, including genetics, breed, nutrition, ambient temperature, endocrine regulation, and management system. However, photoperiod remains the primary environmental factor affecting seasonal reproduction in sheep. Although seasonal effects are less pronounced in males than in females, significant monthly variations in scrotal circumference and semen characteristics have been reported both between breeds and between individuals within the same breed (Pandey et al., 1985; Langford et al., 1998; Salhab et al., 2003). Periods of reduced sexual activity are often characterized by decreased libido, testicular size, hormone secretion, and semen quantity and quality.

Seasonal changes in semen characteristics are mainly attributed to variations in day length throughout the year (Chemineau et al., 1992). In general, sperm quality in rams is superior during summer and autumn compared with winter and early spring (Oberst et al., 2011). Photoperiod has been shown to significantly influence sperm production and fertility in rams (Colas et al., 1985). Nevertheless, other factors such as nutrition, social environment, presence of females, geographical location, age, testicular morphology, body conformation, and libido may also affect semen quality (Al-Ghalban et al., 2004;

Corresponding author: faridmoulla67@gmail.com  
Phone: +213 21521283

Zamiri and Khodaei, 2005; Zarazaga et al., 2005). Under extensive management conditions, nutritional status may exert a stronger influence on reproductive activity than photoperiod alone (Mukasa-Mugerwa and Ezaz, 1992; Perez et al., 1997).

Although several studies have investigated sperm characteristics in Algerian sheep breeds (Aissaoui et al., 2004; Ghoulane et al., 2005; Boucif et al., 2007; Boussena et al., 2014; Benia et al., 2018; Belkhiri et al., 2019; Taherti et al., 2023), no information is currently available on testicular development and semen characteristics of Tazegzawt rams, a critically endangered Algerian sheep breed. Moreover, no longitudinal study has evaluated monthly changes in semen quality and sperm kinematic parameters throughout an entire year in young rams of this breed.

Therefore, the present study represents the first comprehensive assessment of body weight, testicular morphometry and semen characteristics, including CASA-based sperm kinematics, in young Tazegzawt rams reared under semi-extensive conditions in Algeria. We hypothesized that young Tazegzawt rams are capable of producing fertile and viable sperm throughout the year, with seasonal variations in semen quantity and quality. The objective of this study was to assess monthly variations in body weight, testicular measurements and semen characteristics in order to optimize reproductive management and support conservation strategies, including the potential use of artificial insemination, for this endangered sheep breed.

## Materials and methods

### *Location, climatic conditions and ethical approval*

The present study was conducted in collaboration with the Faculty of Natural and Life Sciences of Bejaia University and was carried out at the INRAA experimental station "Oued Ghir" in Béjaïa District, in northeastern Algeria, (36°42'37"N, 4°58'38"E; 66 m above sea level). This area is characterized by a Mediterranean climate with annual temperatures ranging from 12.9°C to 22.1°C and an average annual rainfall of 767 mm.

The experiment was conducted in accordance with the guidelines of Directive 2010/63/EU of the European Parliament on the protection of animals used for scientific purposes and was approved by the relevant institutional ethics Committee.

### *Animals, feeding and management*

This experiment was carried out from January to December using 10 young Tazegzawt rams aged 11 months at the beginning of the study, with body weights ranging between 34 and 54.5 kg. The rams were fed oat vetch hay and commercial concentrate composed of (50% barley, 10% corn, 37.5% wheat bran and 2.5% mineral vitamin supplement). Water

and mineral blocks containing vitamins A, D<sub>3</sub> and E, as well as magnesium, manganese, iron, zinc, cobalt, iodine and selenium were provided ad libitum. Data for all parameters were recorded monthly for each ram from 11 until 22 month of age.

### *Determination of body weight, scrotal and testicular measurements*

Each ram was weighed once a month, concomitantly with scrotal and testicular measurements. Body weight was recorded using a small ruminants scale (maximum capacity 200 kg ± 500 g, Marechalle Pesage, France). The scrotal circumference was measured at the widest point of the scrotum using the flexible metric tape. Testis diameter and length were measured using a sliding calliper after gently pushing each testis against the scrotum wall.

### *Sperm collection and evaluation*

Semen was collected from each ram once a month throughout the study period using an electro-ejaculator (Ruakura probe, length 12 cm, diameter 2.5 cm, Shoof International Ltd., France). In April, semen analysis was not performed due to a failure of the computer-assisted sperm analyzer. A total number of 108 semen ejaculates were collected from 10 Tazegzawt rams during the experiment.

Semen samples were evaluated for volume (mL), sperm concentration per mL ( $\times 10^6$  spermatozoa/mL), sperm motility (%), progressive sperm motility (%) and kinematic parameters (VCL, VSL, VAP, ALH, BCF and STR). Ejaculate volume was measured using a micropipette. The sperm concentration and motility and progressive sperm mobility were assessed using a computer-assisted sperm analyzer (Sperm Class Analyzer, SCA Microptic, S.L., Version 3.2.0, Barcelona, Spain).

Kinematic parameters for each spermatozoon were defined according to Mortimer (2000): curvilinear velocity (VCL; mean velocity of the sperm head along its actual trajectory,  $\mu\text{m/s}$ ); straight-line velocity (VSL; mean velocity measured in a straight line from the beginning to the end of the track,  $\mu\text{m/s}$ ); average path velocity (VAP; mean velocity along the smoothed path,  $\mu\text{m/s}$ ); straightness (STR;  $\text{VSL/VAP}$ , %); linearity (LIN;  $\text{VSL/VCL}$ , %); wobble (WOB;  $\text{VAP/VCL}$ , %); amplitude of lateral head displacement (ALH; mean width of the lateral movement of the sperm head,  $\mu\text{m}$ ) and beat-cross frequency (BCF; frequency of the sperm head crossing the average path, Hz).

Spermatozoa were considered motile when  $\text{VCL} \geq 20 \mu\text{m/s}$  (Marco-Jiménez et al., 2005), rapid (RAP) when  $\text{VCL} > 75 \mu\text{m/s}$  and progressive when STR was at least 80%.

### *Statistical analysis*

All data of body weight, testicular measurements (SC, TD and TL) and spermiatic parameters (SV,

sperm concentration, mobility, progressive mobility and kinematic parameters of sperm) collected in 10 rams throughout the year were subjected to an analysis using SPSS/PASW version 20.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were calculated, and one-way analysis of variance test (ANOVA) was performed to evaluate the effect of month, followed by multiple comparisons. Differences were considered statistically significant at  $P < 0.05$ .

## Results

### Monthly variations in body weight and testicular size

Variations in body weight and testicular parameters between rams and between the months of the year were highly significant ( $P < 0.0001$ ). Mean body weight increased continuously from January and reached its highest value in September ( $66.20 \pm 2.83$  kg). A slight decline was observed in October and November, followed by an increase in December.

Regarding monthly variations in testicular size, the

lowest values of testicular parameters (SC, TD and TL) were recorded from January to March. Testicular size increased from May to November, with the highest values observed during the autumn months, followed by a slight decrease in December (Table 1).

### Monthly variations in sperm characteristics

The mean ejaculate volume was  $0.68 \pm 0.04$  mL. Monthly mean values did not increase linearly with age but showed fluctuations throughout the study period, ranging from  $0.37 \pm 0.07$  mL (minimum value in March) to  $1.13 \pm 0.11$  mL (maximum value in December). Ejaculate volume showed highly significant monthly variations ( $P < 0.0001$ ) but did not differ significantly between rams ( $P > 0.05$ ). Semen production was low from January to March, increased from May to July, slightly decreased in August, and then increased again from September to December.

The average sperm concentration recorded in this study was  $174313 \pm 77.46 \times 10^6$  spermatozoa / mL. Monthly mean values fluctuated throughout the

Table 1. Mean ( $\pm$  SD) body weight and testicular measurements according to individual rams and months in young Tazegzawt rams

Animal	Variable	0.0001***	0.0001***	0.0001***	0.0001***
		BW (Kg)	CS (Cm)	TD (Cm)	TL (Cm)
1		66.34 $\pm$ 2.33	31.92 $\pm$ 0.40	5.77 $\pm$ 0.23	12.22 $\pm$ 0.38
2		68.00 $\pm$ 2.14	31.98 $\pm$ 0.55	6.00 $\pm$ 0.20	13.24 $\pm$ 0.15
3		62.00 $\pm$ 2.06	32.13 $\pm$ 0.22	6.00 $\pm$ 0.16	12.74 $\pm$ 0.26
4		59.33 $\pm$ 2.38	31.92 $\pm$ 0.67	6.12 $\pm$ 0.12	13.16 $\pm$ 0.24
5		56.95 $\pm$ 2.04	30.95 $\pm$ 0.98	5.94 $\pm$ 0.20	13.54 $\pm$ 0.22
6		62.58 $\pm$ 4.63	33.85 $\pm$ 0.45	6.33 $\pm$ 0.18	13.61 $\pm$ 0.16
7		49.21 $\pm$ 1.52	26.34 $\pm$ 0.86	5.15 $\pm$ 0.22	10.19 $\pm$ 0.38
8		60.01 $\pm$ 2.52	32.28 $\pm$ 0.52	6.10 $\pm$ 0.15	11.75 $\pm$ 0.36
9		51.33 $\pm$ 2.01	30.38 $\pm$ 1.14	5.99 $\pm$ 0.23	12.31 $\pm$ 0.28
10		55.55 $\pm$ 1.58	25.39 $\pm$ 0.89	4.98 $\pm$ 0.15	9.92 $\pm$ 0.40
Age (months)	Month measure	0.0001***	0.0001***	0.0001***	0.002**
11	January	48.12 $\pm$ 1.46	28.20 $\pm$ 0.98	4.90 $\pm$ 0.15	11.17 $\pm$ 0.50
12	February	50.20 $\pm$ 2.20	26.96 $\pm$ 1.46	4.94 $\pm$ 0.21	11.05 $\pm$ 0.57
13	March	53.30 $\pm$ 2.35	28.86 $\pm$ 1.21	5.25 $\pm$ 0.16	11.68 $\pm$ 0.44
15	May	56.44 $\pm$ 1.91	30.92 $\pm$ 0.96	5.93 $\pm$ 0.18	12.25 $\pm$ 0.50
16	June	61.70 $\pm$ 1.95	31.71 $\pm$ 0.96	6.05 $\pm$ 0.19	12.15 $\pm$ 0.51
17	July	62.90 $\pm$ 2.27	31.48 $\pm$ 0.77	6.08 $\pm$ 0.15	12.16 $\pm$ 0.50
18	August	63.95 $\pm$ 2.15	31.39 $\pm$ 0.80	6.12 $\pm$ 0.16	12.31 $\pm$ 0.49
19	September	66.20 $\pm$ 2.83	32.17 $\pm$ 0.79	6.20 $\pm$ 0.14	12.64 $\pm$ 0.34
20	October	62.00 $\pm$ 2.02	32.65 $\pm$ 0.75	6.39 $\pm$ 0.14	13.35 $\pm$ 0.33
21	November	61.40 $\pm$ 1.85	32.87 $\pm$ 0.79	6.45 $\pm$ 0.14	13.41 $\pm$ 0.34
22	December	64.50 $\pm$ 1.84	31.09 $\pm$ 0.94	6.10 $\pm$ 0.19	13.03 $\pm$ 0.34
Overall Mean $\pm$ SD		59.31 $\pm$ 8.57	30.80 $\pm$ 0.33	5.87 $\pm$ 0.07	12.31 $\pm$ 0.15

BW: body weight; SC: scrotal circumference; TD: testis diameter; TL: testis length; SD: standard deviation; mean values of body weight and testicular size differed significantly between individual rams and between months (\*\* $P < 0.001$ ).

experiment period, with minimum and maximum values of  $532.44 \times 10^6$  spermatozoa/mL in March and  $2205.89 \times 10^6$  spermatozoa/mL in November, respectively. Sperm concentration did not vary significantly between rams ( $P > 0.05$ ) whereas monthly variations were very significant ( $P < 0.0001$ ). The monthly pattern of sperm concentration was similar to that of ejaculate volume, with low values from January to March, an increase from May to July, a decrease in August, followed by an increase from September to November and a slight decrease in December.

Mean sperm motility was  $68.48 \pm 3.34\%$ . This parameter showed marked monthly fluctuations, with the maximum value recorded in September and October (almost 100%) and the minimum value observed in January (26.66%). Sperm motility was not statistically significantly different between rams ( $P > 0.05$ ) but varied highly significantly between months of the year ( $P < 0.0001$ ). Mean motility

values were lower from January to March (winter and early spring), increased from May to November (late spring summer and autumn), and decreased again in December (Table 2).

#### **Monthly variations in sperm kinematic parameters**

Analysis of average sperm kinematic parameters showed that the sperm velocity parameters (VCL, VSL and VAP), measured objectively using a computer-assisted analyzer, were lowest in January. These parameters increased to reach a first peak in May, decreased in June, and then increased again to reach a second peak in October for VCL and in September and October for VSL and VAP. Thereafter, velocity parameters decreased in November and December.

Monthly mean STR values ranged between 47% and 57%. Although sperm mobility was not progressive (STR < 80%), spermatozoa were motile

Table 2. Mean ( $\pm$  SD) seminal characteristics according to individual rams and months in young Tazegzawt rams

Animal Variable		Semen volume (mL)	Spermatozoa concentration ( $\times 10^6$ /mL)	Sperm mobility (%)
		0.22 (NS)	0.549 (NS)	0.289 (NS)
1		$0.84 \pm 0.19$	$1722.88 \pm 242.95$	$73.41 \pm 10.76$
2		$0.73 \pm 0.09$	$1660.21 \pm 292.43$	$68.23 \pm 10.13$
3		$0.92 \pm 0.14$	$2225.1 \pm 231.93$	$93.15 \pm 5.27$
4		$0.61 \pm 0.11$	$1800.13 \pm 223.27$	$71.75 \pm 11.12$
5		$0.71 \pm 0.08$	$1340.41 \pm 184.62$	$53.32 \pm 12.63$
6		$0.72 \pm 0.09$	$1690.24 \pm 235.01$	$59.25 \pm 9.84$
7		$0.53 \pm 0.11$	$1851.92 \pm 328.07$	$55.75 \pm 13.08$
8		$0.61 \pm 0.06$	$1537.97 \pm 191.83$	$72.44 \pm 8.65$
9		$0.59 \pm 0.07$	$1827.08 \pm 247.83$	$73.93 \pm 10.32$
10		$0.54 \pm 0.09$	$1795.1 \pm 278.02$	$61.31 \pm 11.72$
Age	Collection month	0.0001***	0.0001***	0.0001***
11	January	$0.50 \pm 0.05$	$1439.40 \pm 273.74$	$26.66 \pm 3.20$
12	February	$0.43 \pm 0.09$	$1104.50 \pm 250.26$	$31.55 \pm 10.33$
13	March	$0.37 \pm 0.07$	$532.44 \pm 94.11$	$50.66 \pm 8.81$
15	May	$0.53 \pm 0.08$	$1764.67 \pm 300.97$	$81.94 \pm 11.53$
16	June	$0.66 \pm 0.12$	$1802.56 \pm 300.03$	$72.6 \pm 9.78$
17	July	$0.86 \pm 0.20$	$2148.02 \pm 229.36$	$75.34 \pm 10.87$
18	August	$0.66 \pm 0.08$	$1827.34 \pm 188.61$	$70.04 \pm 12.34$
19	September	$0.72 \pm 0.04$	$1966.84 \pm 126.97$	$98.97 \pm 0.33$
20	October	$0.81 \pm 0.09$	$2197.97 \pm 65.43$	$99.40 \pm 0.29$
21	November	$0.80 \pm 0.05$	$2205.89 \pm 156.71$	$84.15 \pm 6.21$
22	December	$1.13 \pm 0.11$	$2033.30 \pm 211.71$	$56.05 \pm 9.05$
Overall Mean $\pm$ SD		$0.68 \pm 0.04$	$1743.13 \pm 77.46$	$68.48 \pm 3.34$

Mean values of semen parameters differed significantly between months (\*\*\*) ( $P < 0.001$ ) but not between individual rams ( $P > 0.05$ ).

(VCL  $\geq 20 \mu\text{m/s}$ ) throughout the study and showed fast movement (VCL  $> 75 \mu\text{m/s}$ ) in May, September and October months (Fig. 1). Differences in kinematic parameters were not significant between rams ( $P > 0.05$ ) but were highly significant between the months of the year ( $P < 0.0001$ ) (Table 3).

**General assessment of reproductive performance**

Overall, the results indicate that good-quality semen can be collected from young Tazegzawt rams from 15 months of age. This breed appears capable of producing semen of satisfactory quality during most of the year, particularly from May to November, with optimal semen quality observed during the autumn months (September, October and November). Reduced semen quality was observed from January to March for ejaculate volume and

sperm concentration, and from December to March for sperm motility. Consequently, the most favourable period for reproduction occurs during late spring, summer and autumn, whereas reproduction performance is reduced during winter months and early spring.

**Discussion**

To date, no scientific information is available regarding the semen characteristics of the Tazegzawt ram. This study provides the first detailed description of monthly variations in testicular size, semen characteristics and sperm kinematic parameters in young Tazegzawt rams reared in Algeria and raised in semi-extensive management conditions. The originality of this work lies not only in the investigation of a critically endangered local breed, but also in the

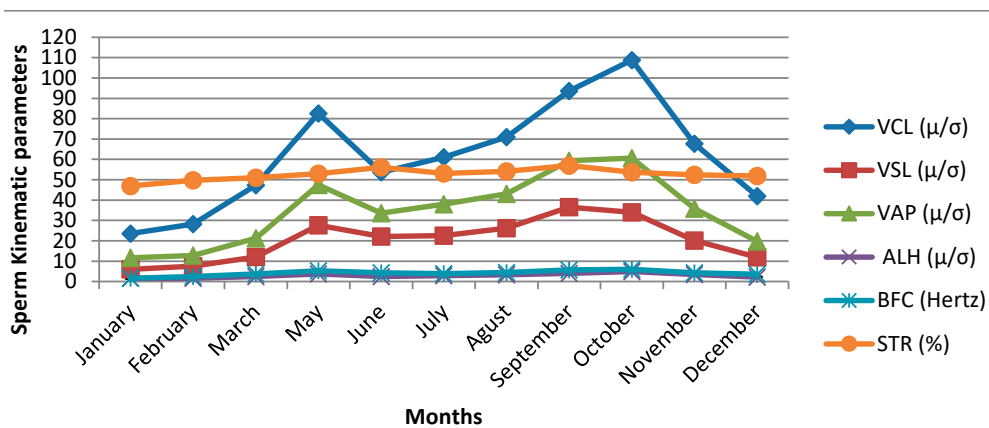


Fig. 1. Mean ( $\pm$ SD) sperm kinematic parameters (VCL, VSL, VAP, ALH, BFC and STR) according to collection month in Tazegzawt rams. Mean values of sperm kinematic parameters differed significantly between the months ( $***P < 0.001$ ).

Table 3. Mean ( $\pm$ SD) kinematic parameters according to individual Tazegzawt rams

Factor of variation	VCL ( $\mu\text{m/s}$ )	VSL ( $\mu\text{m/s}$ )	VAP ( $\mu\text{m/s}$ )	ALH ( $\mu\text{m/s}$ )	BCF (Hertz)	STR (%)
Animal	0.375(NS)	0.860(NS)	0.699(NS)	0.230(NS)	0.590(NS)	0.646(NS)
1	67.47 $\pm$ 11.30	22.7 $\pm$ 4.00	38.13 $\pm$ 7.06	3.13 $\pm$ 0.44	4.69 $\pm$ 0.69	54.62 $\pm$ 1.99
2	61.7 $\pm$ 11.72	18.64 $\pm$ 3.71	33.10 $\pm$ 6.79	3.02 $\pm$ 0.48	3.77 $\pm$ 0.62	52.90 $\pm$ 1.21
3	84.1 $\pm$ 9.93	25.81 $\pm$ 2.82	45.74 $\pm$ 5.50	3.95 $\pm$ 0.40	5.03 $\pm$ 0.42	54.30 $\pm$ 1.42
4	72.16 $\pm$ 12.76	23.38 $\pm$ 4.83	40.34 $\pm$ 7.47	3.34 $\pm$ 0.52	4.17 $\pm$ 0.68	50.74 $\pm$ 2.25
5	52.29 $\pm$ 9.42	19.77 $\pm$ 4.30	30.81 $\pm$ 6.39	2.45 $\pm$ 0.34	3.61 $\pm$ 0.69	52.39 $\pm$ 1.75
6	48.81 $\pm$ 8.22	16.77 $\pm$ 2.74	27.59 $\pm$ 4.81	2.42 $\pm$ 0.33	3.52 $\pm$ 0.47	51.65 $\pm$ 0.63
7	50.57 $\pm$ 10.03	18.73 $\pm$ 4.12	30.69 $\pm$ 6.62	2.43 $\pm$ 0.39	3.53 $\pm$ 0.66	52.29 $\pm$ 2.61
8	58.00 $\pm$ 8.81	20.95 $\pm$ 3.81	34.16 $\pm$ 6.18	2.73 $\pm$ 0.32	4.39 $\pm$ 0.46	54.19 $\pm$ 0.98
9	64.62 $\pm$ 8.95	22.01 $\pm$ 3.78	36.89 $\pm$ 5.81	3.06 $\pm$ 0.35	4.66 $\pm$ 0.68	53.62 $\pm$ 2.41
10	60.73 $\pm$ 10.74	19.02 $\pm$ 3.41	33.59 $\pm$ 6.17	2.96 $\pm$ 0.47	3.86 $\pm$ 0.53	50.21 $\pm$ 1.50
Overall Mean $\pm$ SD	62.27 $\pm$ 3.27	20.82 $\pm$ 1.17	35.19 $\pm$ 1.97	2.96 $\pm$ 0.13	4.13 $\pm$ 0.19	52.70 $\pm$ 0.55

VCL: curvilinear velocity; VSL: straight-line velocity; VAP: average path velocity; ALH: amplitude of lateral head displacement; BCF: beat-cross frequency; STR: straightness.

Mean values of sperm kinematic parameters not differed significantly (NS) between individual rams ( $P > 0.05$ ).

longitudinal monitoring of semen quality over a full annual cycle using a CASA system.

The progressive increase in body weight observed in young Tazegzawt rams throughout the experiment period is consistent with findings reported in ram lambs by Elmaz et al. (2007), Boussena et al. (2014) and Maksimovic et al. (2016). In the present study, mature body weight was not reached by the end of the experiment, suggesting that males of this breed likely complete their growth at approximately two years of age. Significant differences in body weight among individuals can be attributed to the lack of homogeneity in initial body weights at the start of the experiment, which may reflect differences in early-life management and environmental conditions. The significant effect of the month of the year on body weight ( $P < 0.05$ ) is in agreement with results reported by Tabbaa et al. (2006) in yearling Awassi rams.

Testicular size is widely used as an indicator of ram fertility, and testicular morphometry is considered a reliable predictor of sperm production (Abba et al., 2015; Ghorbankhani et al., 2015; Maksimovic et al., 2016). Testicular development depends on several factors, including age, body weight, nutrition and breeding (Ngcobo et al., 2023). In the present study, testicular measurements of young Tazegzawt rams varied throughout the year, with the highest values recorded from May to November (late spring, summer and autumn). In this region, breeding activities are mainly practiced during spring and autumn, and the increase in testicular size during these periods is associated with an increase in sperm production. The lowest testicular measurements were observed from January to March (winter and early spring) followed by a slight decrease in December.

These findings suggest that seasonal variations in testicular size are not strictly governed by photoperiod, as males were capable of producing sperm throughout the year, although reproductive activity was reduced during winter and early spring. Similar reductions in testicular size during winter have been reported in adult Ouled Djellal rams by Belkhir et al. (2019), while Kafi et al. (2004), Tabbaa et al. (2006) and Maksimović et al. (2016) reported the lowest scrotal circumference values during the winter in different sheep breeds. The lower testicular measurements observed at the beginning of the experiment may also be related to incomplete sexual and body development. Oberst et al. (2011) reported more pronounced seasonal variations in scrotal circumference in young Lacaune rams. Overall, the significant effect of the month on testicular size observed in the present study is in agreement with findings by Tabbaa et al. (2006), Elmaz et al. (2007) and Maksimović et al. (2016).

With regard to semen characteristics, pronounced, monthly fluctuations were observed in ejaculate volume, sperm concentration, sperm mobility and sperm kinematic parameters. Semen of good quality

was obtained from May to December for ejaculate volume ( $P < 0.0001$ ) and sperm concentration ( $P < 0.0001$ ) and from May to November for sperm mobility ( $P < 0.0001$ ), with highest mobility values recorded in September and October and highest sperm concentration in October and November. In contrast, sperm mobility and sperm concentration were lower during winter and early spring. In some breeds, however, the effect of the month on semen quality appears less pronounced. For example, Tabbaa et al. (2006) reported that, in yearling Awassi rams, ejaculate volume was affected by month whereas sperm motility and concentration were not.

In the present study, high ambient temperatures and increasing day length did not markedly reduce ejaculate volume, sperm concentration, or mobility. These findings contrast with those of Perez et al. (1997) and Karagiannidis et al. (2000) who reported reduced semen quality in rams during the summer due to high temperatures and day length. Conversely, Ibrahim (1997) observed that semen quality in Chios crossbred rams raised in the United Arab Emirates was not adversely affected during hot summer months.

The mean ejaculate volumes recorded in Tazegzawt rams fell within the general range reported for sheep (0.5 to 2 mL/ejaculate) by several authors (Menchaca et al., 2005; Safdarian et al., 2006), except for the month of February and March. The average ejaculate volume was similar to that reported in yearling Awassi rams ( $0.87 \pm 0.2$  mL; Tabbaa et al., 2006) but lower than the values reported for 18-month-old Ouled Djellal rams ( $1.18 \pm 0.39$  mL; Benia et al., 2018). Lower ejaculate volumes observed at the beginning of the experiment likely reflect the post-pubertal period, as also reported by Salhab et al. (2003) and Boussena et al. (2014). Seasonal decreases in semen volume have previously been reported in Algerian Ouled Djellal rams (Ghozlane et al., 2005; Boucif et al., 2007; Boussena et al., 2014).

The mean concentration recorded in this study ( $1743.13 \pm 77.46 \times 10^6$  spermatozoa/mL) was lower than the range commonly reported in sheep ( $2 \times 10^9$  and  $6 \times 10^9$  spermatozoa/mL (Ghorbankhani et al., 2015; Lavry et al., 2017), but higher than the values reported in local Bangladesh sheep breeds (Hassan et al., 2009). Sperm concentration was numerically lower during later winter and early spring, in agreement with observations by Tabbaa et al. (2006), who reported reduced sperm concentration during late autumn and early winter.

The mean sperm motility ( $68.48 \pm 3.34\%$ ) did not reach the optimal range of 70–80% suggested by Baril et al. (1993). However, monthly values were considered satisfactory from May to November, whereas sperm mobility was reduced during winter and early spring. These changes do not appear to be strongly influenced by photoperiod or temperature, as previously reported Aller et al. (2012). Similarly,

Ghozlane et al. (2005) and Kafi et al. (2004) found no significant effect of photoperiod or high temperature on sperm motility in Ouled Djellal and Persian Karakul rams, respectively.

In conclusion, young Tazegzawt rams exhibit moderate seasonal variation reproductive parameters. All semen parameters analyzed showed reduced values during winter and early spring, whereas semen quality improved markedly during late spring, summer and autumn, with optimal sperm concentration in October

and November and optimal motility in September and October. Interestingly, the seasonal pattern observed in Tazegzawt rams suggests a reduced sensitivity to photoperiod compared with classical short-day sheep breeds. Despite a decline in semen quality during winter and early spring, acceptable semen characteristics were maintained during most of the year, including summer. This feature may represent an adaptive advantage of this breed to mountainous and Mediterranean environments.

## References

- Abba Y., Igbokwe I.O. Testicular and related size evaluations in Nigerian sahel goats with optimal cauda epididymal sperm reserve. *Vet. Med. Int.*, 2015. 5.
- Aller J. F., Aguilar D., Vera T., Almeida G.P., Alberio R. H. Seasonal variation in sexual behavior, plasma testosterone and semen characteristics of Argentine Pampinta and Corriedale rams. *Spanish Journal of Agricultural Research* 2012. 10(2), 345–352. <http://dx.doi.org/10.5424/sjar/2012102-389-11>
- Al-Ghalban A. M., Tabbaa M. J., Kridli, R. T. 2004. Factors affecting semen characteristics and scrotal circumference in Damascus bucks. *Small Rum. Res.*, 2004. Vol. 53, p. 141–149
- Aissaoui C., Chibani J., Bouzebda Z. Etudes des variations de la production spermatique du bélier de race Ouled Djellal soumis à un régime pauvre. *Renc.Rech. Ruminants*, 2004. 11: 402.
- Baril G., Chemineau P., Cognie Y., Guerin Y., Leboeuf B., Orgeur P., Vallet J. C. Manuel de formation pour l'insémination artificielle chez les ovins et les caprins. Rome 1993: FAO: 231p.
- Belkhir Y., Bouzebda-Afri F., Bouzebda Z., Mouffok C., Djaout A. Seasonal variations in reproductive parameters of Ouled Djellal rams in the East of Algeria. *Indian J. Anim. Res.*, 2019. 53(11): 1407–1413, DOI: 10.18805/ijar.v0iOE7266
- Benia A.R., Saadi M. A., Ait Amrane A., Belhamiti T. B., Selles S. M. A. Effet of season and age on main characteristics of sperm production in the Ouled Djellal rams. *Livestock Research for Rural Development*, 2018. 30(1). <https://www.researchgate.net/publication/322446417>
- Boucif A., Azzi N., Tainturier D., Niar A. Variations saisonnières des paramètres reproductifs chez les béliers de deux races locales algériennes. *Renc.Rech.Ruminants* 2007. 14.
- Boussena S., Zaiter S., Aimeur R., Hireche S., Bouaziz O., Derqaoui L. Testicular and spermatoc performance in Ouled Djellal rams during the increasing of day length period. *Arch. Appl. Sci. Res.* 2014. 6(3): 102–107. <https://www.researchgate.net/publication/290813116>
- Chemineau P., Malpoux B., Delgado J. A., Guerin Y., Ravault J. P., Thimonier J., Pelletier J. 1992. Control of sheep and goats reproduction: use of light and melatonin. *Anim. Reprod. Sci.*, 2018. Vol. 30 p. 157–184
- Colas G., Guérin Y., Clanet V., Solari A. Influence of the photoperiod on production and fecundity of spermatozoa in adult Ile-de-France ram. *Reprod. Nutri. Dev.* 1985. 25, 101–111.
- El Bouyahiaoui R., Arbouche F., Ghozlane F., Moulla E., Belkheir B., Bentrhoua A., Hidra H., Mansouri H., Igouera M., Bellahreche A., Djaout A. Répartition et phénotype de la race ovine Bleue de Kabylie ou Tazegzawt (Algérie). *Livestock Research for Rural Development* 2015. 27(10): 214. <http://www.lrrd.org/lrrd27/10/arbo27214.html>
- Elmaz O., Cirit U., Demir H. Relationship of testicular development with age, body weight, semen characteristics and testosterone in Kiircik ram lambs. *South African Journal of Animal Science* 2007. 37(4).
- Ghorbankhani F., Souri M., Moeinin M.M., Mirmahmoudi R. Effect of nutritional status on sperm characteristics, testes size and serum testosterone concentration in Sinjabi ram lambs during natural breeding season. *Anim. Reprod. Sci.*, 2015. 153, 22–28., DOI: 10.1016/j.anireprosci.2014.12.006
- Ghozlane F., Ziki B., Yakhlef H. Variations saisonnières des caractères quantitatifs du sperme de bélier de race Ouled Djellal. *Renc. Rech. Ruminants*, 2005. 12: 164.
- Hassan, M. R. Pervage S., Ershadazzaman M., Talukder M. A. I. Influence of age on the spermogram parameters of native sheep. *J. Bangladesh Agril. Univ.*, 2009. 7, 2: 301–304.
- Ibrahim, S.A. Seasonal variations in semen quality of local and crossbred rams raised in the United Arab Emirates. *AnimReprod. Sci.* 1997. 49, 161–167.
- Kafi M., Safdarian A., Hashemi M. Seasonal variation in semen characteristics, scrotal circumference and libido of Persian Karakul rams. *Small Ruminant Res.*, 2004. 53 (1-2): 133–139, DOI: 10.1016/j.smallrumres.2003.07.007
- Karagiannidis A., Varsakeli S., Alexopoulos C., Amarantidis I. Seasonal variation in semen characteristics of Chios and Friesian rams in Greece. *Small Rumin Res.*, 2000. 37:125–130. [http://doi.org/http://dx.doi.org/101016/S0921-4488\(99\)00143-1](http://doi.org/http://dx.doi.org/101016/S0921-4488(99)00143-1)
- Langford G.A., Shrestha J.N.B., Sanford L.M., Marcus G.J. Reproductive hormone levels of early post pubertal ram lambs in relation to breed, adult testis size and semen quality. *Small RuminRes.*, 1998. 29:225–231.
- Lavry G.N., Coulibaly M.B., Offoumou A.M., Datte J.Y. Three-year monthly variations in the spermogram of Djallonké rams in the forest region of Cote d'Ivoire. *Rev Elev Med Vet Country Too*, 2017. 69 (3): 111–116
- Maksimovic N., Hristov S., Stankovic B., Petrovic M.P., Mekic C., Ruzic-Muslic D., Cardo-Petrovic, M. Investigation of serum testosterone level, scrotal circumference, body mass, semen characteristics, and their correlations in developing MIS lambs. *Turk. J. Vet. Anim. Sci.*, 2016. 40: 53–59.
- Menchaca A., Pinczak A., Queirolo D., Storage of ram semen at 5°C: effects of preservation period and timed artificial insemination on pregnancy rate in ewes. *Anim. Reprod.* 2005. 2(3): 195–198. <https://www.animal-reproduction.org/article/5b5a6088f7783717068b47fb>
- Marco-Jiménez F., Puchades S., Gadea J., Vicente J.S., Vides-De-Castro M.P., Effect of semen collection method on pre- and post-thaw Guirra ram spermatozoa. *Theriogenology*, 2005. 64(8):1756–1765. <https://doi.org/10.1016/j.theriogenology.2005.04.006>
- Moulla F., El bouyahiaoui R., Belkheir B., Hidra H., Igouera M. Sexual development in Tazegzawt male lambs: body, testicular and penile growth before pre-puberty. *Tropical Agriculture*, 2022. 99(1): 65–74. <https://journals.sta.uwi.edu/ojs/index.php/ta/article/view/8187>
- Mortimer, S.T. CASA-practical aspects. *J. Androl.* 2000. 21, 515–524.
- Mukasa-Mugerwa, E., Ezaz, Z. Relationship of testicular growth and size to age, body weight and onset of puberty in Menz ram lambs. *Theriogenology* 1992. 38, 979–988
- Ngcobo J.N., Nedambale T.L., Mpofu T.J., Nephawe K.A., Chokoe T.C., Ramukhithi F.V. Seasonal variations in semen quality testosterone levels and scrotal size following dietary flaxseed oil and ascorbic acid in South African indigenous rams. *Animals*, 2023. 13 (7):1213. DOI: 10.3390/ani13071213
- Oberst E.R., Smirdele A., Brito M., Marschner T.R., Ribeiro L.A., Mattos R.C. Seasonal variation in semen quality of la-caune rams in Brazil. *Braz. J. Vet. Res. Anim. Sci.*, São Paulo, 2011. 48(4): 319–324. <https://doi.org/10.11606/S1413-95962011000400007>
- Pandey R.P., Sinha S.N., Singh B., Akhtar M.H. Characters of semen and fertility rate in Saanen and Barbari bucks. *Indian J. Anim. Sci.*, 1985. 55:773–774.

31. Perez C., Lopez A., Castrillejo A., Biell, Laborde D., Gastel T., Tagle R., Queirolo D., Franco J., Forsberg M., Rodriguez-Martinez H. Reproductive seasonality of Corriedale rams under extensive rearing conditions. *Acta Vet. Scand.* 1997. 38, 109–117.
32. Safdarian M., Hashemi M., Kafi M. Seasonal changes in semen quality, scrotal circumference and blood testosterone level of Persian Karakul rams. *Book of Abstracts of the 57th Annual Meeting of the European Association for Animal Production (EAAP)*, Antalya, Turkey, 2006. 203.
33. Salhab S.A., Zarkawi M., Wardeh M.F., Al-Masri M.R., Kassem R. Characterization and evaluation of semen in growing Awassi ram lambs. *Trop. Anim. Health Prod.*, 2003. 35: 455–463. <https://doi.org/10.1023/A:1025823730733>
34. Tabbaa M.J., Kridli R.T., Al-Ghalban A., Barakeh F.S. Age-related changes in scrotal circumference and some semen characteristics in Awassi rams. *Anim. Reprod.* 2006. 3(4): 431–438.
35. Taherti M., Ait Issad N., Khelef D., Mimoune N. Reproduction characteristics of OuledDjellal rams in a semi-arid area in Algeria. *Kafkas Univ Vet Fak Derg.*, 2023. 29 (6): 717–726, DOI: 10.9775/kvfd.2023.30329
36. Zamiri, M. J., Khodaei H. R. Seasonal thyroidal activity and reproductive characteristics of Iranian fat-tailed rams. *Anim. Reprod. Sci.*, 2005. Vol. 88, p. 245–255
37. Zarazaga L. A., Guzman J. L., Dominguez C., Perez M. C., Prieto R. Effect of plane of nutrition on seasonality of reproduction in Spanish Payoya goats. *Anim. Reprod. Sci.*, 2005. Vol. 87, p. 253–267.