Effect of nutrition on live weight and testicular development in Ouled Djellal ram lambs during the prepubertal period in Western Algeria

Zineddine Esma and Bereki Reguig Karima

INTRODUCTION

In Algeria, sheep breeding represents 80% of the total domestic animal production (with 26.88 millions head) and mutton provides more than 58% of the national red meat production [18,10]. The Ouled Djellal is the main native sheep breed. It is adapted to steppe conditions and has exceptional qualities for red meat and wool production [9]. Recognition of the reproductive characteristics of a sheep breed is an essential starting point towards improving its productivity [8].

Improving productive and reproductive traits of sheep can be done using several approaches. Genetic improvement of animals is one of these approaches and can be performed by selection [2]. Progress in improving productive and reproductive traits, especially in growth and meat production characteristics, is a major aim for sheep breeding because the efficiency of production primarily depends on these traits [28].

In male sheep, reproductive activity is affected by a range of external factors, including socio–sexual cues, temperature, photoperiod and nutrition. Among these factors affecting rams, nutrition is arguably the most powerful factor [16].
The effects of nutrition on livestock fertility have been relatively poorly studied in males compared to females [25]. Whereas the male breeding animal makes an important contribution to the reproductive performance and genetic improvement in a herd/flock [16]. Therefore, the characterization of puberty and early sexual development is a valuable tool for selection within the males of a breed [14]. Selection of the appropriate breeding strategy on small ruminant farms is requisite for optimizing reproductive performance. A major consideration for this goal is the selection of pre-pubertal females and/or males for replacement animals [22]. However, an adequate plane of nutrition is also of vital importance for normal development of ram lambs and the rate of sexual development is highly dependent on the growth rate of the animal [29].

In general, sexual development of ram lamb which the onset of puberty is more closely related to body weight and size than to age [30]. Furthermore, a review by Toe et al. [24] suggested that measures of testicular size have received considerable attention as possible selection criteria for improving fertility in sheep. How these events proceed throughout prepubertal development determines the future reproductive capability of the adult male. Therefore, it is important to closely monitor this phase of sexual development in order to be able to predict future fertility and to diagnose any reproductive complications [31].

The aim of this experiment was to evaluate the effect of level of concentrate feed on prepubertal period in Ouled Djellal ram lambs and also to determine relationship between testicular and live weight growth performances of the animals throughout the trial.

**MATERIALS AND METHODS**

The present study was conducted at the Technical Institute Farms (I.T.ELV) Lamtar of Sidi-bel-Abbes (Western Algeria). This farm is located in Lamtar (25 Km on the road to Tlemcen), at an altitude of 560 m (average minimum temperature 10.38°C, average maximum temperature 25.22°C, annual rainfall 372 mm). Twenty Ouled Djellal lambs of 3-4 months old were used. The lambs were weaned at 100 ± 10 days of age and then housed in a sheepfold under natural condition. They were weighed and allotted into two equal groups of Low (n = 10) or High (n = 10) nutrition plane. Each group received, in addition to a basal diet (good quality pasture) 200 g and 400 g of concentrate feed containing barley (50%), corn (10%), wheat bran (37.5%) and vitamin mineral compound (2.5%) by head/day, respectively. Lambs concentrate feed contained also 92.36% dry matter which it composed of: 72.68% carbohydrates, 15% proteins, 2% lipids, 1% calcium, 0.55% phosphorus and vitamins (A: 500000 UI, D3: 75000 UI, E: 1000 UI). Hay and water were provided ad libitum. At the date of 15th March the lambs were identified by numerated loops in the ear. Body weight and testicular volume of lambs were measured monthly for 3 months (15April - 15 June 2015). The volume of testis was calculated as reported by Marson et al. [17]. The length and width of each testis were measured with a calliper after forcing it against the scrotum [32].

Volume Testicular (cm³) = \( W \times L \times \pi / 6 \) (with W: testicular width and L: testicular length)

The animals were healthy and a general management program for de-worming, disease prevention, and hoof trimming was followed during the experiment.

All statistical analyses were carried out using the Stat View program (version 5; 1998 France SAS Institute Inc.). Data were analyzed using the "Student t test" (with a 5% significance level). Correlations between measurements were obtained by means on the Pearson correlation test.

**RESULTS AND DISCUSSION**

*Assessment of weight gain:*

*Live weight:*

The average means and standard deviations of live weights for different age periods are shown in Table 1. Live weights increased continuously at different average ages respectively 20.22 ± 2.11 kg at 102 ± 11.86 days to 23.57 ± 1.95 kg at 133 ± 11.86 days and 26.55 ± 2.59 kg at 163 ± 11.86 days (significant difference: p <0.0001). Results in the present study indicated that the average lamb live weights of the two groups (Low and High) tend to increase throughout during the trial. The means live weights of lambs on diet Higher were significantly higher than those for animals on the diet Lower (18.65 ± 1.02 vs 21.80 ± 1.70 kg: significant difference with p = 0.001), (22.15 ± 0.94 vs 25.00 ± 1.63 kg: significant difference p = 0.0018), and (24.30 ± 0.71 vs 28.80 ± 1.56 kg: very significant difference with p <0.0001). However, increasing the concentrate component of feed intake indicates an apparent influence on weight gain which it mentioned with the findings 3.15 kg, 2.85 kg and 4.5 kg respectively between the lambs of low and high groups.
Table 1: Changes in live weight (kg) in Ouled Djellal ram lambs according to the average age.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Effective (102 days)</th>
<th>Effective (133 days)</th>
<th>Effective (163 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Low</td>
<td>n=10</td>
<td>18.65±1.02 a</td>
<td>22.15±0.94 a</td>
</tr>
<tr>
<td>Group High</td>
<td>n=10</td>
<td>21.80±1.70 b</td>
<td>25.00±1.63 b</td>
</tr>
<tr>
<td>AM± SD*</td>
<td>n=20</td>
<td>20.22±2.11 a</td>
<td>23.57±1.95 b</td>
</tr>
</tbody>
</table>

* Total average mean and standard deviation

a, b, c: Values with different letters in the same column are significantly different (p < 0.05).

α, β, ω: values with different superscripts in the same row are significantly different (p <0.0001).

Our values were superior to comparable compared with results reported by Titaouine [21] which has advanced average of 16.92 ± 1.22 kg, and 22.56 ± 1.50 kg respectively for 90 days and 120 days in Appearance lambs Ouled Djellal keeping at the cradle region of this breed of sheep (Wilaya of Biskra) although Yilmaz and Altin [23] have advanced an average of 19.71 kg at 100 days of age in lambs from Chios cross breed Kyvreck × F1 in Turkey. Whereas Santos et al. [27] enregistered an average live weight of 20.2 ± 2.9 Kg at 4 months of age in Croix ram lambs in Mexico while Chowman [33] obtained 21.82 ± 1.18 Kg at 6 months of age in Karadi ram lambs in Iraq.

Our results were also higher than those estimated by some Algerian authors who recorded alive means weight of 15.79 ± 2.15 kg and 18.85 ± 3.05 kg at 60 days and 120 days respectively in race lambs Rembi in Tariet (western Algeria) [3]. As for the level of the Mediterranean basin, for example, in Tunisia, averages 15 to 20 kg at the age of 3 months to 3.5 months at the Ghezala farm and 18-23 Kg at 3.5 months of age in farm Fretissa at the same breed of sheep called the Sicil- Sarde [20] while Chafri and Mahouachi [6] found an average of 14.2 kg at 24 weeks or 6 months of age in lambs D’man race receiving a high diet. In Morocco, Elfadili [7] reported an average of 17.24 ± 0.35 kg at 90 days in the local race Beni Guil. However, our results were lower than those recorded by Boussena et al. [5] who obtained average weight of 22.07 ± 0.94 kg, and 25.82 ± 1.17 kg, respectively, at 90 days and 120 days in breed lambs Ouled Djellal late weaned at an average age of 122.65 ± 1.18 kg and housed at the demonstration farm of the technical institute farms Ain M’lila (North- East Algeria) while Lamrani et al. [13] who noted an average live weight of 31.09 ± 0.98 kg at 6 months of age in lambs of the same race at the Guelma region (North- East Algeria). Therefore, Jiménez-Severianoa et al. [34] mentioned an average weight of 40.4±9 Kg at 168 days in Blackbelly ram lambs in Mexico and also Jaquiey et al. [35] reported an average live weight of 30.3 Kg at 12 weeks of age in Romney ram lambs in New Zealand. However, Muammer et al. [36] reported 27.67 ± 1.43 Kg, 35.72 ± 1.94 Kg, 36.33 ± 1.88 Kg, 34.42 ± 1.05 Kg at 3 months, 4 months, 5 months and 6 months of age respectively in Turkish Tju lambs.

In general, the significant increase in live weight may be explained by the dietary transition that suffered the lamb during the weaning period which the milk food was replacing by the solid food and he received a high level of concentrate energy. It will allow to transform the monogastric to a ruminant (development of other gastric pouches and increasing the efficiency of the digestive tract). However, Tanri Giling Rasyid et al. (2016) confirmed that using a concentrate feed and good management of by-products of goat were a significant change in experimental group by improving farming goat.

Our results differ significantly more or less compared to those obtained by other authors because there are several factors influencing the weight of lambs in the post- weaning period (weaning age: early or late weaning), genotype (breeds) factors related to the mother (maternal age, parity, maternal qualities, level of milk production etc.), type of birth (single or double), diet (food transition, quantity and quality concentrated and distributed availability and forage type offered including individual intake capacity of the lamb) and the type of farming (intensive, semi-intensive or extensive depending on the type of production).

Assessment of testicular growth:

Testicular Volume:

Testicular weight cannot be measured in the living animal, but has been estimated in several ways, such as scrotal circumference, testis diameter, length and volume. Testicular size is a highly heritable trait, and considered to be a reliable predictor of sperm production by the testis in rams [24]. Furthermore, lambs having larger testes produce more sperm later [19]. Table 2. summarize the development of testicular volumes of Ouled Djellal ram lambs during the present trial.
Table 2: Changes in testicular volume in Ouled Djellal ram lambs according to the average age.

<table>
<thead>
<tr>
<th>Testicular Volume (Cm³)</th>
<th>Effective (102 days)</th>
<th>(133 days)</th>
<th>(163 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Low</td>
<td>n=10</td>
<td>33.11±4.56</td>
<td>39.04±5.45</td>
</tr>
<tr>
<td>Group High</td>
<td>n=10</td>
<td>36.41±7.56</td>
<td>43.71±7.09</td>
</tr>
<tr>
<td>AM± SD*</td>
<td>n=20</td>
<td>34.76±6.31</td>
<td>41.38±6.60</td>
</tr>
</tbody>
</table>

* Total average mean and standard deviation
The values in the same column are not significantly different (p > 0.05).
α, β, ω : values with different superscripts in the same row are significantly different (p <0.0001).

Our results revealed that a gradual and linear increase in testicular volume from 3 till 6 months of age of both High and Low groups which it recorded the values: 34.76 ± 6.31 Cm³ to 102 ± 11.86 days and 41.38 ± 6.60 Cm³ 133 ± 11.86 days while 53.12 ± 10.87 Cm³ was estimated at 163 ± 11.86 days (highly significant difference with p <0.001). This finding is in agreement with that observed by Attal et al. [1] who reported that testicular growth is initially slow during the period of infancy, is accelerating between 3 and 12 months in the establishment of spermatogenesis in the Normande cattle breed males. However, during prepubertal testicular development, there is a remarkable increase in cellular number and diversity within the seminiferous tubules owing mainly to the onset of spermatogenesis [31].

A gradual and linear increase in testicular volume was observed from 3 to 6 months of age for both of the Low and High groups with the findings were 33.11 ± 4.56 vs 36.41 ± 7.56 Cm³: no significant difference with p = 0.23), (39.04 ± 5.45 vs 43.71 ± 7.09 Cm³ : no significant difference with p = 0.12 ) and (48.54 ± 12.00 vs 57.69 ± 7.67 Cm³ : no significant difference with p = 0.06), although the beginning of the experiment, a slight gap was gradually observed 3.29 Cm³ , 4.67 Cm³ to reach the threshold of 9.14 Cm³ until the end of the experiment (6th month corresponding to the pre-pubertal age).

Our results were lower than those reported by Kahal [11] who advanced the following values : 37.62 ± 4.52 cm³, 47.39 ± 5.01 cm³, 62.79 ± 6.98 cm³ to 3 months, respectively, 4 months and 5 months of age in Ouled Djellal ram lambs keeping at the experimental station of EL-Meniaa and receiving two levels of dietary supplementation based on barley (250g or 500g / head / day). While Koyuncu et al. (2005) reported an average testicular volume (measured by immersing the testicles in a graduated container of water) of 87.57 ± 5.92 cm³, and 157.49 ± 5.98 cm³ to 2 months and 6 months of age respectively in Turkey Kivircik ram lambs (farming system intensive and weaning at 60 days). However, Chowman (2016) obtained 14.31 ± 3.66 Cm³, 77.66 ± 23.54 Cm³ at 6 months and 7 months of age respectively in Karadi ram lambs in Iraq.

Our results differ significantly from those reported by other authors as lambs in experiment were receiving different diets related to the types of forage offered and the quality and quantity of concentrate supplementation consumed. Furthermore, methods of measurement of testicular volume differs from one operator to another (callipers, orchidometer, graduated with water container .... etc.). The differences among all the studies in the literature also may be due to breed, age, season and feeding strategies and other environmental/management practices.

Correlations between different parameters (age, live weight and testicular volume):

Live weight of Ouled Djellal ram lambs were positively correlated with the age according both of the two groups (High : R= 0.96 and Low : R= 0.96). Our results were similar to those reported by Elmaz et al. [8] which showed strong correlation between age and weight (R = 0.89).
Testicular volume of Ouled Djellal ram lambs were positively correlated with the age according to both of the groups (High : R= 0.72 and Low : R= 0.66). Our findings were in agreement with those reported by Elmaz et al. [8] which showed strong correlation between age and weight (R = 0.83).

Y = 9.062 + 3.508 * X; R^2 = .937

Fig. 01: Development of live weight (Kg) in Ouled Djellal ram lambs from 3 to 6 months of age (Low group)

Y = 10.067 + 2.837 * X; R^2 = .923

Fig. 02: Development of live weight (Kg) in Ouled Djellal ram lambs from 3 to 6 months of age (High group)

Y = 8.216 + 7.81 * X; R^2 = .436

Fig. 03: Development of testicular volume (Cm³) and live weight (Kg) in Ouled Djellal ram lambs from 3 to 6 months of age (Low group)
Fig. 04: Development of testicular volume (Cm³) in Ouled Djellal ram lambs from 3 to 6 months of age (High group)

\[ Y = 3.872 + 9.145 \times X; R^2 = .528 \]

Fig. 05: Development of testicular volume (Cm³) and live weight (Kg) in Ouled Djellal ram lambs from 3 to 6 months of age (Low group)

\[ Y = -16.601 + 2.619 \times X; R^2 = .428 \]

Fig. 06: Development of testicular volume (Cm³) and live weight (Kg) in Ouled Djellal ram lambs from 3 to 6 months of age (High group)

\[ Y = -16.71 + 2.486 \times X; R^2 = .512 \]
Regression equation presented in Figure 6 describe the relationship with body weight and testicular volume of ram lambs of both the two groups (High : R = 0.65 and Low : R= 0.71). In agreement with Chafrı et al. [37] reported that scrotal circumference is strongly correlated with live weight of lambs D'man race with a coefficient of R= 0.95 and Elmaz et al. [8] which showed strong correlation (R = 0.86) between body weight and testicular volume. These results also corroborated those of Chowman [33] who recorded (R = 0.54, R = 0.68 at 6 months and 7 months of age respectively in Karadi ram lambs in Iraq.). The trend of testicular and body growth noticed in this study was similar also to that described by Mahouachi et al. [15] in Dman lambs. In addition Ghorbankhani et al. [26] reported that the monthly pattern of testicular circumference, the body weight of Sanjabi ram lambs in Iran also gradually increased during the trial.

Conclusions:

Depending on the results of the present study it was possibly to confirm the effect of a high level and adequate diet on weight and testicular growth in Ouled Djellal ram lambs from the early age just after weaning until the prepuberital age of six months. Moreover, a close relationship was found between the different parameters live weight, testicular volume and age of the animals throughout the period of the experiment. Therefore, the nutrition management (focus feeding) during the crucial period of development may be a useful tool to maximize productivity in flocks and it can be considered to reduce the costs of keeping surplus ram lambs. Future research should concentrate on other substances mediating the effects of nutrition on the production of semen.

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REFERENCES


