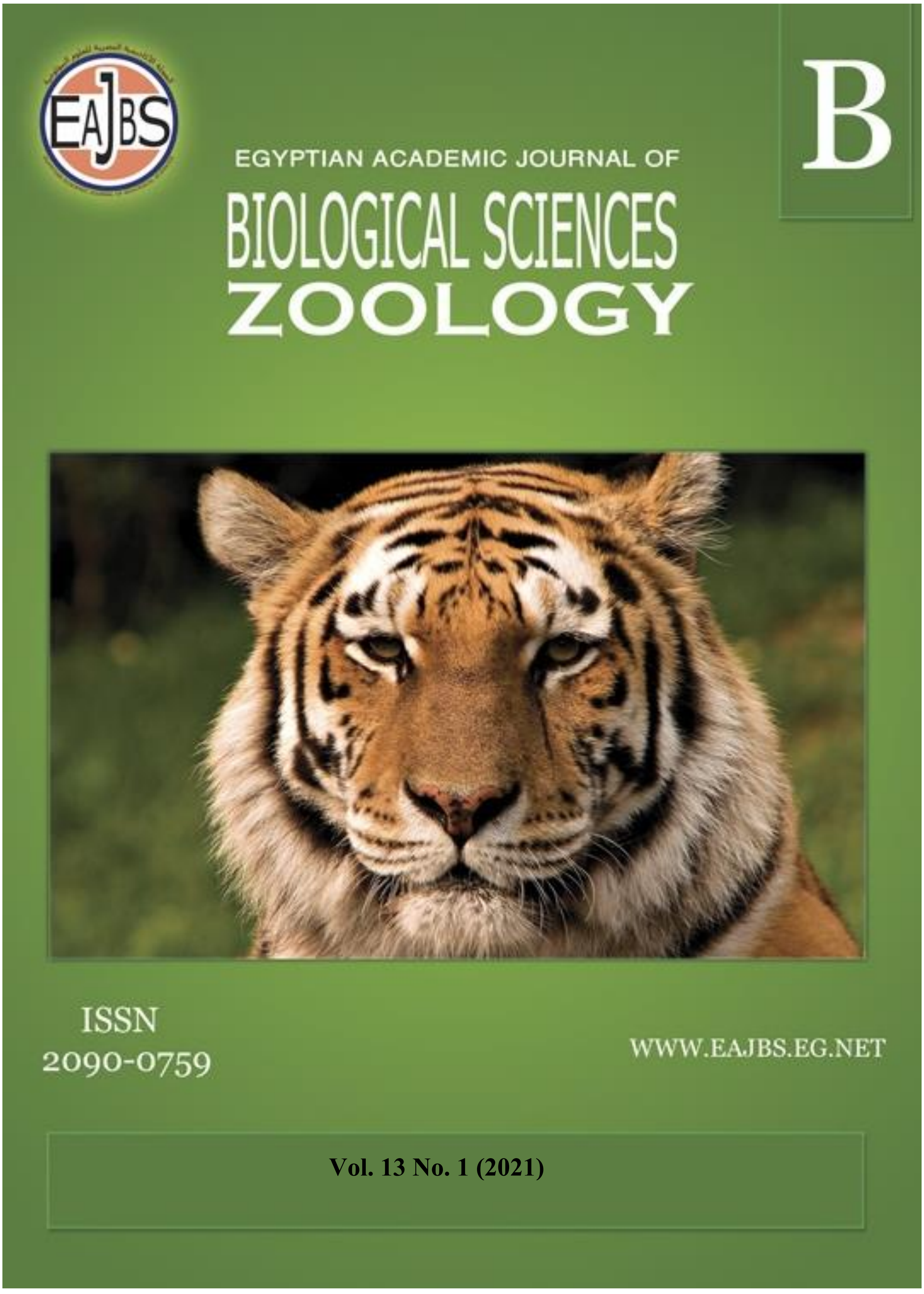

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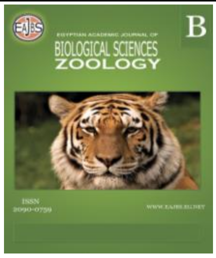

Effect of Dietary Energy Levels on The Performances of Testicular Development, Live Body Weight and Testosterone Concentration in Ouled Djellal Ram Lambs

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ABSTRACT

The aim of our study was to determine the effect of the dietary energy levels on the live body weight, testis volume and blood testosterone concentration in Ouled Djellal ram lambs throughout growth. The study lasted six months from post-weaning until the pubertal period at the Technical Institute Farms (I.T.E.L.V) Lamtar of Sidi-bel-Abbes (Western Algeria). After weaning, Twenty single-born *Ouled Djellal* ram lambs from 90 to 240 days old were weighed and allotted into two equal groups of Low energy ($n = 10$) or High energy ($n = 10$) nutrition plane. Each group received; in addition to a basal diet (good quality pasture) 200 g and 400 g of concentrate feed mixture containing barley (60%), corn (5%), wheat bran (37.5 %) and vitamin-mineral compound (2.5 %) by $head^{-1}day^{-1}$ respectively. Hay and water were provided ad libitum. Monthly measurements of live body weight, testicular volume and blood testosterone concentration of lambs were recorded. The results showed that the High energy group of lambs recorded a significantly higher live body weight compared to the lambs of low energy group ($p < 0.001$). Whereas, the testicular growth indicated a gradual and linear increase for both groups (low energy and high energy) with significant differences ($p < 0.001$). However, all measurements of the testis, live body weight, serum testosterone levels and age were positively correlated with one another of both low and high groups throughout the experiment. In conclusion, High-level energy supplementation can improve to enhanced development in Ouled Djellal ram lambs this may be due to its beneficial effect on the productive and reproductive performance of growing male lambs. Furthermore, using younger lambs may reduce production costs, accelerate the benefits of genetic selection, and allow earlier progeny and libido testing.

INTRODUCTION

The Ouled Djellal is the main native sheep breed of the Biskra regions of Algeria. It has a thin tail and short earsc and produces meat and wool. Besides Biskra, the Ouled Djellal breed is also found in Sidi bel abbès and other regions of Algeria. Ouled Djellal sheep produce good quality meat and respond well to genetic improvement through selection. They are also known for their ability to walk long distances and the ability to cope with harsh

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environmental conditions such as long periods of drought and high temperatures (Dekhili, 2010). Studies have been conducted on the testicular development of Ouled Djellal rams, though to a limited extent (Dekhili and Mahane 2004 ; Dekhili and Benkhlif, 2005). However, as far as we know, no study has been conducted on the relation between testicular dimensions and reproductive hormones of Ouled Djellal ram lambs.

Puberty is difficult to define because of the complexity of the mechanisms of growth development that occurs during puberty and maturity. Hafez (2009) found that puberty is basically the result of gradual adjustment between increasing gonadotropic activity and the ability of gonads to simultaneously assume steroidogenesis and gametogenesis. Male and female lambs with high scores for early puberty and distinctive sexual behavior can improve flock fertility during breeding and indirectly improve genetics (Ibarra *et al.*, 2000). Mating behavior and reproductive success are hormone-dependent in both sexes. Serum testosterone level has a high correlation with the sexual performance of rams during mating (Abdullah *et al.*, 2010).

In fertility studies in livestock, there is a tendency to focus more on the female side with much less emphasis on the male side. However, male fertility is as important as that of the female (Davidson and Farver, 1980). Measures of testicular size have received considerable attention as possible selection criteria for improving fertility in sheep, primarily because of their high heritability, and their favourable to neutral association with female reproduction (Toe *et al.*, 2000).

Characterization of puberty and early sexual development is a valuable tool for selection within the males of a given breed. The onset of puberty in sheep is influenced by genetic and environmental factors such as breed, climate, nutrition and strain differences. Workers on age at puberty agree that the early age is associated with the time of birth and the nutritional planes (Khalifa *et al.*, 2013). Elmaz *et al*. (2007) reported clearly that there is a significant and positive correlation between testicular measurements and semen characteristics (progressive motility, semen volume) in ram lambs at the age of seven to eight months. Therefore, this can be used as a selection criterion to use ram lambs at an early age. This application can also be considered to reduce the costs of keeping surplus ram lambs.

The aim of our study was to measure the development of live weight and testis and to investigate the relationship between testis volume with body growth and serum testosterone levels in growing ram lambs.

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 months old were used. The lambs were weaned at 90 days of age and then housed in a sheepfold under natural conditions. They were weighed and allotted into two equal groups of Low energy (n = 10) or High energy (n = 10) nutrition plane. Each group received; in addition to a basal diet (good quality pasture) 250 g and 500 g of concentrate feed mixture containing barley (60%), corn (5%), wheat bran (37.5 %) and vitamin-mineral compound (2.5 %) by $head^{-1}day^{-1}$ respectively. Lambs concentrate feed contained also 92.36% dry matter which is 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). The good hay and fresh water were available ad libitum at all times of the experiment. Bodyweight, testicular volume and Testosterone concentration of lambs were measured monthly for 6 months (01 March to 01 Août 2015). The volume of testis was calculated as reported by

Marson *et al.* (1991). The length and width of each testis were measured with a caliper after forcing it against the scrotum:

Testis Volume (Cm^3) = W2 x L x π / 6 (with W: testicular width and L: testicular length).

The blood samples were collected from the jugular vein once per month, between 09h00 and 11h00, for all animals during the experiment. On the day of sampling, the blood was immediately centrifuged at 3000 rpm for 15 min and the serum was stored at -20 C°until assay. Testosterone concentration was determined by Chimiluminescence using an ARCHITECT i4000 with a commercial kit (ARCHITECT 2nd GenerationTestosterone reagent kit product by ABBOTT; Etas-Unis).

All statistical analyses were carried out using the Stat View program (version 5; 1998 France SAS Institute Inc.). Data were analyzed by ANOVA with repeated measurements with Greenhouse-Geisser correction (with a 5% significance level). Correlations between measurements were obtained by means of the Pearson correlation test. All graphics were plotted using Excel Microsft 2013.

RESULTS AND DISCUSSION

Assessment of Weight Gain:

Live Weight:

Live body weight (kg) of male lambs consumed Low and High energy rations post-weaning at 90 days up to 240 days is illustrated in (Fig. 1 and Table. 1**)**, respectively. Also, it is of interest to note that the values of Live body weight of lambs with the High Energy group tended to be higher (P < 0.001) than those of the Low Energy group at all measuring time**.** The results revealed that the average Live body weight of either ration Low Energy group or the High Energy group tended to be gradually increased with development animal's ages (r = 0.97 vs r = 0.98)**.** The changing in the Live body weight of lambs had fed High Energy group diets may be related to energy intake. A similar trend has been observed by Hosseini *et al.* (2008) who found that energy is the major dietary element that is responsible for the different utilizations of nutrients, thereby the productivity and body gain of an animal. Moreover, high levels of minerals were also shown to have a positive influence on ultimately lamb weights at weaning and puberty (El-Zelaky *et al.*, 2011).

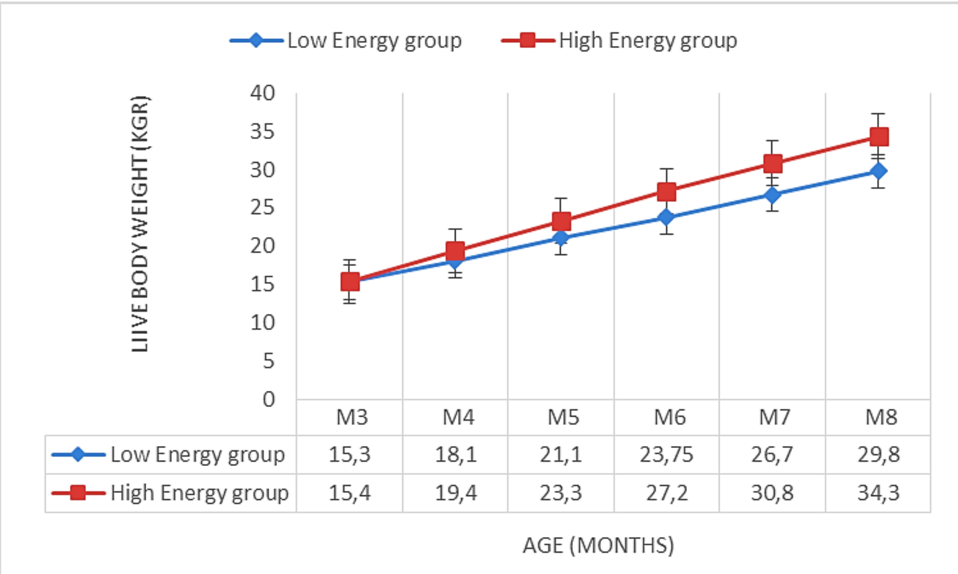

Fig 1 : Changes in mean live weight (Kg) of Ouled Djellal rams from 90 to 240 days of age.

Table 1 : Changes in live body weight (kg) in Ouled Djellal ram lambs during all the experiments.

	Month	Mean ± Standard Deviations	Minimum	Maximum	Test « ANOVA»
Group of Low Energy (n=10)	March	15,30 ± 0.26 kg	15 kg	15.50 kg	p<0.001
	April	18.10 ± 0.39 kg	17.5 kg	19 kg	
	May	21.10 ± 0.61 kg	20 kg	22 kg	
	June	23.75 ± 0.82 kg	23 kg	25 kg	
	July	26.70 ± 0.86 kg	25.50 kg	28 kg	
	August	29.80 ± 1.14 kg	28 kg	32 kg	
Group of High Energy (N=10)	March	15.40 ± 0.39 kg	15 kg	16 kg	
	April	19.40 ± 0.39 kg	19 kg	20 kg	
	May	23.30 ±0.42 kg	23 kg	24kg	
	June	27.20 ± 0.48 kg	26.50kg	28 kg	
	Juillet	30.80 ± 0.67 kg	30 kg	32 kg	
	Août	34.30 ± 0.53 kg	33.50 kg	35 kg	

These results are in agreement with the results by Titaouine (2015) who reported that Ouled Djellal ram lambs reached means live weight of 16.92 ± 1.22 kg and 22.56 ± 1.50 kg respectively at 90 days and 120 days in Appearance lambs *Ouled Djellal* keeping at the cradle region of this breed of sheep (Wilaya of Biskra). Also, Benchohra *et al.* (2014) showed that means the 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 Tiaret (Western Algeria). However, our results were lower than those recorded by Boussena *et al.* (2013) who obtained an 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 farm Ain M'lila (North - East Algeria) while Lamrani *et al.* (2015) 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).

In Tunisia, means 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 *Sicilo- Sarde* (Rouissi *et al.*, 2001) while Chafri and Mahouachi (2011) 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 (2008) reported an average of 17.24 ± 0.35 kg at 90 days in the local race *Beni Guil*. Although Yilmaz and Altin (2011) have advanced an average of 19.71 kg at 100 days of age in lambs from *Chios cross breed Kıvırcık × F1* in Turkey. Whereas Santos et al. (2015) registered an average live weight of 20.2 ± 2.9 Kg at 4 months of age in Croix ram lambs in Mexico while Chowman (2016) obtained 21.82 ± 1.18 Kg at 6 months of age in *Karadi* ram lambs in Iraq. Therefore, Jiménez-Severianoa *et al.* (2010) mentionned 40.4±.9 Kg at 168 days in *Blackbelly* ram lambs in Mexico and also Jaquiéry *et al.* (2012) 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.* (2010) 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.

Our results differ significantly more or less compared to those obtained by other authors because they live body weight in sheep is influenced by genetic (breed), type of birth (simple or double), age at weaning (early or late weaning), factors related to the mother (maternal age, parity, maternal qualities, level of milk production...etc.) and environmental factors such as climate, nutrition: type of diet (food transition, quantity and quality of concentrated distributed, forage type offered including feed conversion efficiency of the lambs, type of supplementation: energy, proteins or minerals) and the type of farming (intensive, semi-intensive or extensive depending on the type of production).

Assessment of Testicular Growth:

Testicular Volume:

Testis volume during the experimental period is shown in (Fig. 2. and Table. 2) The male lambs treated with High Energy group had higher ($P < 0.001$) average testis volume (110.85 ± 10.08 Cm^3) than lambs fed Low Energy group (96.27 ± 13.33 Cm^3) during all the experimental period.

Our results indicate that a gradual and linear increase in testicular volume from 3 till 8 months of age of both Low and Higher Energy groups which it recorded the values (33.11 ± 4.56 Cm^3 vs 62.77 ± 9.03 Cm^3) and (96.27 ± 13.33 Cm^3vs 110.85 ± 10.08 Cm^3) at 90 days to 180 days respectively ($p < 0.001$). This finding is in agreement with that observed by Attal *et al.* (1963) who reported that testicular growth is initially slow during the juvenile period, is accelerating between 3 and 12 months in the establishment of spermatogenesis in the *Normande* cattle breed males. However, during pubertal testicular development, there is a remarkable increase in cellular number and diversity within the seminiferous tubules owing mainly to the onset of spermatogenesis (Giffin *et al.*, 2014).

A rapid increase in testis volume was observed between 140 to 160 days of age when a testicular activity was observed, although this was more pronounced at 180 days and 240 days ($r = 0.90$ vs $r = 0.91$) for both the High energy and Low energy groups of lambs. The results are in agreement with Elmaz *et al.* (2007) who reported that it was established a significant and positive correlation between testicular measurements and semen characteristics (progressive motility, semen volume) in Kivircik ram lambs at the age of seven to eight months. Therefore, this can be used as a selection criterion to use ram lambs at an early age. Similary, Marson *et al.* (1991) showed that hormonal changes during puberty in male *chimpanzees* and the increase in testosterone concentration were parallel to the increase in testicular volume. Koyuncu *et al.* (2005) indicated that regression equations have revealed that testicular size was positively related to body weight and age in lambs and there was concluded a significant and positive correlation between testicular volume and live body weight in ram lambs at the age of seven to eight months ($r = 0.96$). The positive correlations were found between prepubertal lamb hormone levels and subsequent either testes size or age.

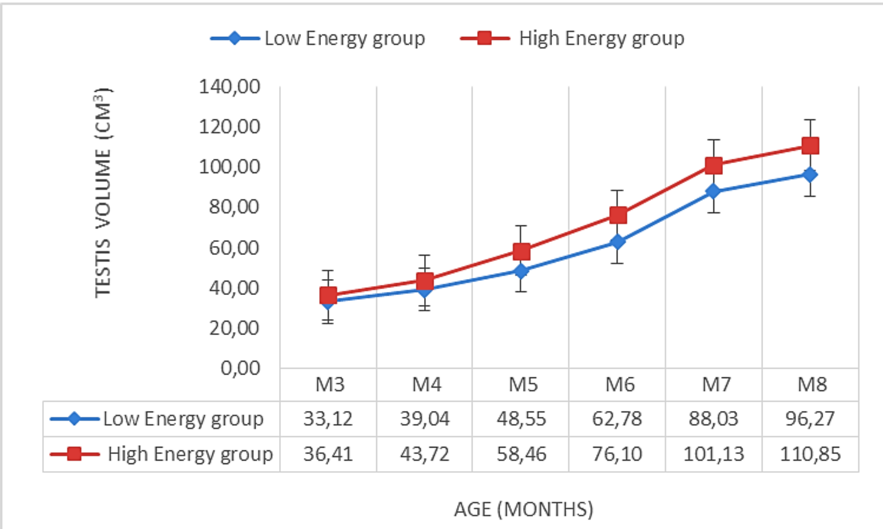

Fig. 2 : Changes in mean Testis volume (Cm^3) of Ouled Djellal rams from 90 to 240 days of age.

Table 2 : Changes in Testis volume (Cm^3) in Ouled Djellal ram lambs during all the experiments.

	Month	Mean ± Standard Deviations	Minimum	Maximum	Test « ANOVA »
Group of Low Energy (n=10)	March	33.11 ± 4.56 Cm^3	26.36 Cm^3	40.80 Cm^3	**p<0.001**
	April	39.04 ± 5.45 Cm^3	30.77 Cm^3	48.85 Cm^3	
	May	48.54 ± 12 Cm^3	32.29 Cm^3	66.76 Cm^3	
	June	62.77 ± 9.03 Cm^3	48.56 Cm^3	75.39 Cm^3	
	July	88.03 ± 11.80 Cm^3	72.10 Cm^3	101.43 Cm^3	
	August	96.27 ± 13.33 Cm^3	77.90 Cm^3	114.88 Cm^3	
Group of High Energy (n=10)	March	36.41 ± 7.56 Cm^3	26.79 Cm^3	48.56 Cm^3	
	April	43.71 ± 7.09 Cm^3	34.01 Cm^3	51.92 Cm^3	
	May	57.69 ± 7.67 Cm^3	40.17 Cm^3	66.76 Cm^3	
	June	76.09 ± 11.37 Cm^3	55.91 Cm^3	90.55 Cm^3	
	July	101.13 ± 13.19 Cm^3	75.14 Cm^3	118.68 Cm^3	
	August	110.85 ± 10.08 Cm^3	88.96 Cm^3	123.23 Cm^3	

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 (Toe *et al.*, 2000). Furthermore, lambs having larger testes produce more sperm later (Oatley *et al.*, 2005).

Our finding was lower than values obtained by Kahal (2010) who advanced the means testis volume of 37.62 ± 4.52 cm^3, 47.39 ± 5.01 cm^3, 62.79 ± 6.98 cm^3 at 3 months, 4 months and 5 months of age, respectively, in Ouled *Djellal* ram lambs keeping at the experimental station of EL- Meniaa and receiving two levels of energy supplementation based on barley (250 g or 500 g / 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 *Kivircik* ram lambs in Turkey (farming system intensive and weaning age at 60 days). However, Chowman (2016) enregistred 14.31 ± 3.66 Cm^3, 77.66 ± 23.54 Cm^3 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 because the lambs used in the experiment were receiving different types of supplementation (energy, protein, or minerals) and other types of forage were offered. Furthermore, methods of testis volume measurements are different from one practicer 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, other factors related to the environment and management practices breeding.

Adibmorad *et al.* (2012) showed that Twenty-four goat kids were assigned to three equal groups and received one of three dietary treatments as follows: control (CO), soybean oil (SO), or fish oil (FO). All three diets were isonitrogenous and isoenergetic but contained different fat sources. Prilled palm oil (high in C16 :0), soybean oil (high in C18 :2 n-6) and fish oil (high in EPA 20 :5 n-3 and DHA Docosahexaenoic Acid 22 :6 n-3) were supplemented at 2% DM to control, soybean oil and fish oil diets, respectively. In this study source of dietary fat significantly affects testes developments and spermatogenesis in the goat and the current results show that the fish oil diet positively affects gonad development in the goat and that when dietary DHA level increased, better gonad development could observe.

Kridli *et al.* (2006) indicated that Scrotal circumferences were significantly lower ($P < 0.05$) in *Awassi* (A) than in *Romanov* × *Awassi* (RA) and *Charollais* × *Awassi* (CA) first cossbred lambs. Scrotal circumference differs among breeds of sheep (Belibasaki and Kouimtzis, 2000 ; Kridli *et al.,* 2002) being higher in crossbred than purebred lambs. There was a significant ($P < 0.05$) linear sampling day effect with respect to the scrotal circumference.

Schanbacher (1988) reported that testis size was maximum in light-treated rams at the time of the summer solstice, a finding in sharp contrast to that normally observed for rams in June. Other Groups A and B photostimulated rams maintained large testis size into the fall breeding season and through the end of the study. Early recrudescence of the testis during the season of normal sexual quiescence and the advantage maintained by these photostimulated rams over rams exposed to the natural photo environment appear to be coupled to stimulation of the hypothalamo-pituitary-testicular endocrine axis. Luteinizing hormone (LH) secretion by the pituitary and testosterone secretion by the testis increased in advance of the testicular hypertrophy observed in photostimulated rams during early spring. Associated with the elevated plasma testosterone levels were an increased sexual flush and increased incidence of Flehmen and sexual aggressiveness. Physical aggressiveness and the number of male-male confrontations was increased also. Maintaining high fertility by genetically superior rams producing large numbers of high-quality spermatozoa, is important for the improvement of overall flock fertility (Rege *et al.,* 2000). By using rams with a high concentration of spermatozoa in their testes, more ewes per ram can be employed; conception rates would increase and the percentage of non-pregnant ewes would be reduced (Gherardi *et al.,* 1980). However, evidence of a relationship between testicular size and spermatological characteristics is inconclusive. While some researchers suggested that testicular size provided a good index of testicular sperm output in rams (Lino, 1972), others reported that biweekly scrotal measurements were poorly correlated with semen quality in adult rams (Langford *et al.,* 1987). Fernandez *et al.* (1999) did not record a relationship between testicular size and sperm production. In contrast, testicular volume during late spring was correlated with sperm production in autumn.

Our results indicate a significant positive correlation between testis volume, live body weight and age of Ouled Djellal ram lambs for High energy and Low energy groups respectively ($r = 0.96$ vs : $r = 0.88$). In agreement with Chafri *et al.* (2008) showed that scrotal circumference is strongly correlated with the live weight of lambs *D'man* race ($R = 0.95$). These results also corroborated those of Chowman (2016) 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.* (2011) in *Dman* lambs. In addition, Ghorbankhani *et al.* (2015) reported that the monthly pattern of testicular circumference, the bodyweight of *Sanjabi* ram lambs in Iran also gradually increased during the experiment. Also, Elmaz *et al.* (2007) enregistred a strong correlation ($r = 0.86$) between body weight and testicular volume and showed that a significant positive correlation was found at seven and eight months of age between all testicular measurements and semen volume and motility. These results demonstrated that testicular measurements, especially scrotal circumference, can be used as criteria for the early selection of ram lambs to be used in breeding at relatively young ages.

Serum Testosterone Levels:

The development of serum testosterone concentrations during all the experiments from 90 to 240 days is presented in (Fig 3. and Table 3). A significant increase has been observed in the testosterone hormone levels in ram lambs with High Energy group (1.24 ±

0.34 ng/ml) compared to the Low Energy group (1.41 ± 0.30 ng/ml) and reaches a maximum value between the ages of 210 to 240 days for two groups (p<0.001). Similarly, (Khalifa *et al.*, 2013) showed that the increase in serum testosterone concentration is linear during the pre-pubertal period and reaches a maximum value between the ages of 215 to 235 days.

The testosterone levels were low at the start of the experiment and it was gradually increased with advanced age (r = 0.77 vs r = 0.75) and parallel with the increase of live body weight (r = 0.74 vs r = 0.74) for both of High energy and Low energy groups of lambs. The body weight and testicular size as affected by chronological age may be attributed to active testosterone secretion (p<0.001).

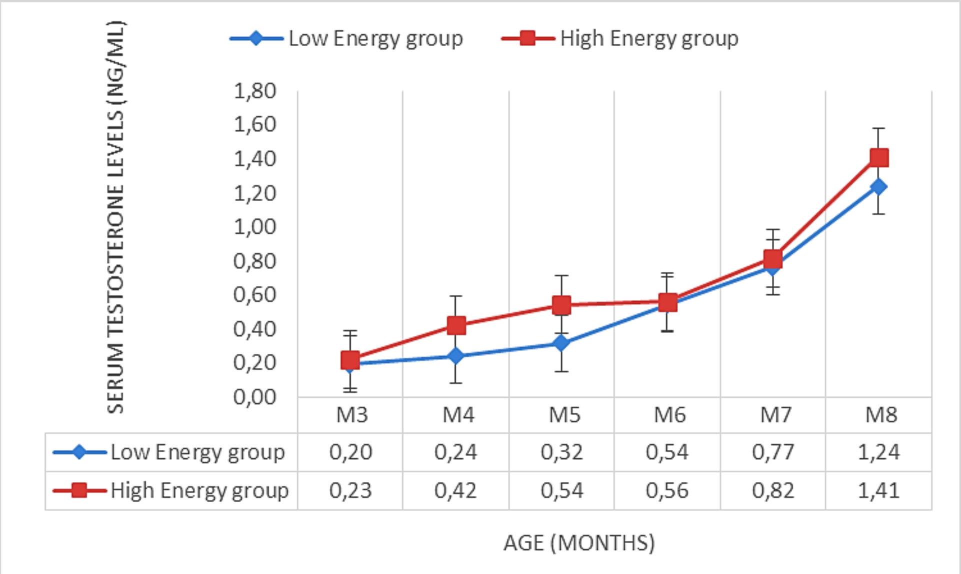

Fig. 3 : Changes in mean Testosterone levels (ng/ml) of Ouled Djellal rams from 90 to 240 days of age.

Table 3 : Changes in Testosterone levels (ng/ml) in Ouled Djellal ram lambs during all the experiments.

	Month	Mean ± Standard Deviations	Minimum	Maximum	Test « ANOVA»
Group of Low Energy (n=10)	March	0.19 ± 0.04 ng/ml	0.11 ng/ml	0.25	**p<0.001**
	April	0.24 ± 0.13 ng/ml	0.13 ng/ml	0.51	
	May	0.32 ± 0.23 ng/ml	0.13 ng/ml	0.75	
	June	0.54 ± 0.14 ng/ml	0.40 ng/ml	0.80	
	July	0.77 ± 0.18 ng/ml	0.58 ng/ml	1.19	
	August	1.24 ± 0.34 ng/ml	1.00 ng/ml	2.1	
Group of High Energy (n=10)	March	0.23 ± 0.12 ng/ml	0.11 ng/ml	0.47	
	April	0.39 ± 0.20 ng/ml	0.13 ng/ml	0.87	
	May	0.54 ± 0.23 ng/ml	0.13 ng/ml	0.83	
	June	0.56 ± 0.10 ng/ml	0.42 ng/ml	0.75	
	July	0.82 ± 0.28 ng/ml	0.49 ng/ml	1.55	
	August	1.41 ± 0.30 ng/ml	1.02 ng/ml	2.11	

The first signs of testicular development were detected in May-June and reached their maximal values (96.27 ± 13.33 vs 110.85 ± 10.08 cm3) in August, for the Low and High

Energy groups, respectively. Also, the maximal values of serum testosterone levels were enregistred, in August, for the Low and High Energy groups, respectively (1.24 ± 0.34 ng/ml vs1.41 ± 0.30 ng/ml). Howerver, Schanbacher (1988) reported that mean testosterone levels for these rams were generally below 1 ng/ml during the nonbreeding season, began to increase in late spring and early summer and then returned to breeding season values (between 5 and 10 ng/ml) the next fall.

In Egypt, Aslani *et al.* (2007) showed that the Jatropha cake that remains after oil extraction contains a high protein level approximately 45-50% yet it could be considered as a feed supplement for livestock producers. However, El-Zelaky *et al.* (2011) had determined the effect of 70% Jatropha cake replaces by soybean on feedlot and reproductive performance of Rahmani male lambs. A significant increase ($P < 0.05$) has been observed in the testosterone hormone levels in ram lambs with Jatropha group (2.45ng/ml) compared to the control group (1.99 ng/ml). In general, the increase in serum testosterone concentration is linear during the pre-pubertal period and reaches a maximum value between the ages of 215 to 235 days for the two groups. Also, El-Saidy *et al*. (2004) found that serum testosterone concentrations were low at the early stages of puberty and gradually increase with chronological age. The testosterone hormone concentration had a fluctuating trend independent of the diet type. Similarly, Fernández *et al*. (2004) reported that testosterone hormone concentration had fluctuations for rams fed with protein diets. Also, zinc in Jatropha meal activated the synthesis of testosterone hormone (Rubio *et al*., 2007). It could be concluded that Jatropha cake can replace up to 70% of soybean meal in CFM (Concentrate Feed Mixture) without any adverse effect on lambs performance. Jatropha supplement succeeded improve puberty premature and early semen collection. Feed conversion efficiency and feed economics also improve by Jatropha supplement.

Khalifa *et al.* (2013) had established a comparison between the effect of Microbial Inoculation Corn Silage (MICS) and corn silage (CS) on sexual characteristics and production of male and female *Rahmani* lambs. According to the results obtained in this study, It could be confirmed that microbial inoculation can be preserved corn silage and can improve its chemical composition and ruminant value that refluxed on productive and reproductive performance of growing male and female lambs. Furthermore, microbial inoculation provides a cheap energy and protein source for the ruminant animals which reduces the cost of feeding. Also, Titi *et al.* (2008) showed that biological inoculant supplementation increased digestibility with enhancing effect on growth performance, feed intake, or feed conversion ratio of lambs and kids.

El-shahat_*et_al.* (2010) reported that *Rahmani* ewes lambs of 6-7 months of age and average body eight 24.75 ± 0.16 kg were fed a basal diet of hay (64.2%) and barley grain (35.0%) plus minerals and vitamins (0.8%). The first group was kept as control and was fed a basal diet. Ewes lambs in the second group received the same basal diet supplemented with Calcium Salts of long-chain Fatty Acids (CSFA) at 3% of the basal diet dry matter intake (1.2 kg/ewe/d). Results indicated that the dietary supplementation with CSFA to *Rahmani* ewes lambs attained puberty 5 weeks earlier than the control one. CSFA supplementation of *Rahmani* ewe lambs has higher body weight, and body condition score than those of the control one (34.67 ± 0.30 kg 3.25 ± 0.09 vs. 30.67 ± 0.95 kg 2.0 ± 0.0 ; $p < 0.05$ respectively). The highest concentrations of Insulin-like Growth Factor-1 (IGF-1) were significantly ($P < 0.05$) detected at 2nd 4th and 10th weeks (258.42±6.0, 228.76 ±14.44 and 337.32 ±24.57 ng/ml, respectively) than those of control one (163.3 ±11.94, 135.5 ± 3.07 and 218.47 ± 9.18 ng/ ml, respectively). In conclusion, calcium soap supplementation led to early puberty in *Rahmani* ewe lambs this may be due to their beneficial effect on rumen and general metabolic pools led to improvements in the energy and lipids status of the supplemented *Rahmani e*we lambs and earlier attainment of puberty.

Kridli *et al.* (2006) conclude that ram lambs were considered to be pubertal based on elevated testosterone concentrations (2 ng/ml) and the presence of normal spermatozoa in the ejaculate with at least 30% mass motility over two consecutive semen collections. This testosterone level was adopted as Dufour *et al*. (1984) reported a 2.5 ng/ml average testosterone concentration in Suffolk rams. For animals to reach puberty, their circulating hormones have to reach adult levels. Testosterone concentration increased as the experiment advanced. The overall testosterone concentration differed significantly (P< 0.05) among genotypes with *Romanov* × *Awassi* (RA) and *Charollais* × *Awassi* (CA) having higher concentrations than Awassi lambs. Testosterone concentrations did not differ among genotypes during the first few weeks of the experiment. The difference in Scrotal Circumference noted above was reflected in testosterone concentration in favor of crossbred ram lambs. Testosterone concentrations increase linearly with age and may differ between pure and crossbred rams (Fahmy, 1997) and among breeds of sheep (Dickson and Sanford, 2005). Crossing *Awassi* with *Romanov* improved reproductive performance in the crosses through advancing age at puberty in males and females and improving semen quality in males. Crossing *Awassi* with *Charollais* advanced age at puberty in males and females but had no influence on semen quality in males compared with *Awassi*.

Selvaraju *et al.* (2012) reported that rams in the low-energy group were fed with diets 20% less energy than the control energy group (optimum energy, 100%, recommended energy level), whereas rams in the high energy group were fed diets with 20% more energy than the optimum energy group. The serum and seminal plasma IGF-I levels were significantly (P <0.05) higher in control and high energy fed groups as compared to the low energy group. The serum testosterone level was significantly (P < 0.05) higher in the control group as compared to the low-energy group. The serum testosterone levels were significantly (P < 0.05) higher in the optimum energy-fed group as compared to the low-energy group. However, no difference was observed between low and high-energy groups. In the high energy group, the testosterone levels were lower (P = 0.1) as compared to the optimum energy group. A significantly higher serum testosterone content in control dietary energy than low-energy fed animals suggested the influence of energy levels on endocrine signaling pathways. Metabolic modulators can act on the hypothalamus-pituitary-gonadal axis as well as on the regulatory feedback mechanism. In rams, an increase in the intake of energy and protein increased the frequency of pulses of GnRH and LH, and the tonic secretion of FSH (Martin and Walkden-Brown, 1995) and (Adam, 1998). An earlier study suggested that the gametogenic tissue responds rapidly to changes in nutrition, but the endocrine compartments are less affected (Martin and Walkden-Brown, 1995). Though the effects of high energy diet on male reproductive functions were not clearly understood, the energy levels might induce a shift in the volatile fatty acid profiles in the rumen and might have influenced reproductive tract fluid composition through an altered energy metabolism, insulin, and or insulin-like growth factor I concentrations as reported in cows (Leroy et *al.*, 2008).

Khalifa *et al.* (2013) showed the male lambs treated with R2 (concentrate feed mixture + wheat straw+ corn silage) had higher (P < 0.05) average plasma testosterone concentration (2.20± 0.23 ng/ml) than lambs fed R1 (concentrate feed mixture + wheat straw+ corn silage + microbial inoculation corn silage) (1.53± 0.34 ng/ml) through puberty period. The testosterone levels were low at the early stages of sexual development in all tested groups and gradually increased with advanced age. The body weight and testicular size as affected by chronological age may be attributed to active testosterone secretion. The male lambs with bigger testes produced more testosterone levels than the lambs with smaller testes. Prepubertal testicular growth rates have been used to predict the adult testicular size and spermatogenic function. Koyuncu *et al.* (2005) reported that testicular size was positively related to body weight and age in lambs. The positive correlations were found between prepubertal lamb hormone levels and subsequent either testes size or age. These previous results agreed with Elmaz *et al.* (2007) who concluded that testosterone concentration was 0.4 and 2.5 ng/ml when testes volume 17.3 and 211.9 cm3 with 100 and 200 days of age, respectively. The present trend of increase pubertal based on elevated testosterone concentrations higher than 2.5 ng/m. The superiority of R2 lambs compared to R1 lambs in testosterone levels may be related to improving energy intake. This finding agreed with that reported by Scott *et al.* (2011) who found that the mechanism underlying this sex-specific effect of testosterone is may be due to sexual differentiation of the brain centers controlling energy expenditure. However, Tjondronegoro *et al*. (1998) indicated that changes in testicular size, caused by an increase or decrease of a protein supply, were positively correlated with changes in secretion of gonadotrophins and testosterone.

Conclusion

According to the results obtained in this study, it could be confirmed that High-level energy supplementation can improve the development of *Ouled Djellal* ram lambs this may be due to its beneficial effect on the productive and reproductive performance of growing male lambs. Furthermore, using younger lambs may reduce production costs, accelerate the benefits of genetic selection, and allow earlier progeny and libido testing. These data justify the need for further studies on the relationship between sexual behavior and blood testosterone concentration in ram lambs through the onset of puberty. The benefits of advanced puberty in lambs may be accentuated in year-round breeding programs that can take advantage of the development of early fertility.

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ARABIC SUMMARY

تأثير مستويات الطاقة الغذائية على نمو الخصية، وزن الجسم الحي وتركيز هرمون التستوستيرون لدى حملان سلالة أولاد جلال

زين الدين، أ. بريكسي رقيق، ك. كانون خ.، ماي، ه.

1- قسم الأحياء ، كلية الطبيعة وعلوم الحياة ، جامعة جيلالي ليابس ، سيدي بلعباس ، الجزائر.

2- مختبر علم الأحياء الدقيقة الجزيئي ، الصحة والبروتيوميات ، قسم الأحياء ، كلية العلوم الطبيعية والحياة ، جامعة جلالي ليابس بسيدي بلعباس ، الجزائر.

كان الهدف من دراستنا هو تحديد تأثير مستويات الطاقة الغذائية على وزن الجسم الحي وحجم الخصية وتركيز هرمون التستوستيرون في الدم في لحم الحملان أولاد جلال طوال فترة النمو. استمرت الدراسة ستة أشهر من فترة ما بعد الفطام حتى سن البلوغ في مزارع المعهد الفني (I.T.E.L.V) لمطار بسيدي بلعباس (غرب الجزائر). بعد الفطام، تم وزن عشرين من الحملان المولودة من قبل أولاد جلال من 90 إلى 240 يومًا وتقسيمها إلى مجموعتين متساويتين من الطاقة المنخفضة (ن = 10) أو عالية الطاقة (ن = 10) مستوى التغذية. تلقت كل مجموعة؛ بالإضافة إلى النظام الغذائي الأساسي (المراعي الجيدة) 200 جرام و400 جرام من خليط العلف المركز الذي يحتوي على الشعير (60٪) والذرة (5٪) ونخالة القمح (37.5٪) ومركب الفيتامينات المعدنية (2.5٪) عن طريق الرأس-1 يوم -1 على التوالي. تم توفير التبن والماء بالشهرة الإعلانية. تم تسجيل القياسات الشهرية لوزن الجسم الحي وحجم الخصية وتركيز هرمون التستوستيرون في الدم للحملان. أظهرت النتائج أن مجموعة الحملان عالية الطاقة سجلت وزنًا حيًا أعلى معنويًا مقارنة بالحملان منخفضة الطاقة (P <0.001). في حين أشار نمو الخصية إلى زيادة تدريجية وخطية لكلا المجموعتين (طاقة منخفضة وطاقة عالية) مع وجود فرق معنوي (P <0.001). ومع ذلك، فإن جميع قياسات الخصية ووزن الجسم الحي ومستويات هرمون التستوستيرون في الدم والعمر كانت مرتبطة بشكل إيجابي مع بعضها البعض من كلا المجموعتين المنخفضة والمرتفعة خلال التجربة. في الختام، يمكن لمكملات الطاقة عالية المستوى أن تحسن التنمية المعززة في حملان أولاد جلال، وقد يكون هذا بسبب تأثيره المفيد على الأداء الإنتاجي والإنجابي للحملان الذكور المتنامية. علاوة على ذلك، قد يؤدي استخدام الحملان الأصغر سنًا إلى تقليل تكاليف الإنتاج، وتسريع فوائد الانتقاء الجيني، والسماح باختبار النسل المبكر والرغبة الجنسية.

الكلمات المفتاحية: وزن الجسم الحي، أولاد جلال كباش الحملان، النظام الغذائي، حجم الخصية، التستوستيرون.