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Testosterone concentration and its relationship to growth performance and testicular measurements of Sohagi ram lambs

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Abstract

Androgen testosterone is essential for the development of sexual behavior in rams. This study investigated the relationship among testosterone concentration, growth performance and testicular measurements of Sohagi ram lambs. Eight healthy Sohagi ram lambs (5 months of age, weighing an average amount 23.13 ± 2.7 kg) were used to study growth performance, testicular development and testosterone concentration for 8 months (until 13 months of age). The body weight, body measurements and testicular measurements were recorded once a month during the experimental period. To estimate plasma testosterone concentration, blood samples were collected once a month. Results showed that all measurements obtained were developed from 5 to 13 months of age in ram lambs, and there is a strong and positive correlation among testosterone concentration and other studied measurements. Finally, appropriate methods must be followed in the management and nutrition of ram lambs especially in the first period of life and with the onset of puberty and the development of reproductive characteristics, in order to improve the reproductive efficiency of the breeding herds and thus maximize the revenue from those herds.

Keywords: Sohagi ram lambs, growth performance, testosterone, testicular measurements.

INTRODUCTION

Sheep production efficiency in developing countries is important especially for smallholder farmers (because of their little nutritional requirements) which mainly depends on the reproductive efficiency (Elaref *et al*., 2021 & 2020). Puberty and early sexual development characteristics are useful tools for breed selection. (El-Shahat *et al*., 2014). In addition, Moulla *et al*. (2018) determined that defining the precise onset of puberty is extremely difficult, especially for species that reproduce seasonally. The primary determinant of puberty is the interplay among body weight, testicular growth, and testosterone release throughout the prepubescent period. (Martinez *et al*., 2012). Moreover, Bosman, (1999) reveled that secretion of testosterone in sufficient quantities by the testes helps in showing clear signs of masculinity, and any imbalance or deficiency in the testosterone hormone in the male is reflected in the shape of the body and could cause a lack of expressed masculinity. Arnold *et al*. (1997) showed that rams' testosterone levels mirror their increasing neck and front quarter muscle, which is linked to their sexual maturity. Flock performance and reproductive efficiency are more affected by the fertility of a ram than by the fertility of an individual ewe, thus selection of highly fertile male is of paramount importance for improvement in reproduction (Faith *et al*., 2019). Sohagi sheep is one of the most prevalent types of sheep in Upper Egypt, which used by small farmers to improve their livelihoods and annual income (Solouma *et al*., 2022). Full information on reproductive performance of Sohagi ram lambs and their sexual behavior development are lacking (Elaref *et al*., 2021). This work aimed to investigate the relationship between testosterone concentration and both growth performance and testicular measurements in Sohagi ram lambs.

MATERIALS AND METHODS

The Animal Production Department of the Faculty of Agriculture at El-kawthar City Sohag University, situated in the western arid regions of the Sohag governorate, Egypt, is where the current study was carried out.

Animal and management conditions

Eight healthy Sohagi ram lambs (5 months of age, with average body weight 23.13 ± 2.7 kg) were used to study growth performance, testicular development and testosterone concentration for 8 months (until 13 months of age). Animals were housed in closed barns and they were given diets to fulfill their daily needs in accordance with to NRC (2007). Freshwater is available all time of day from a fixed drinking through.

Growth performance, testicular measurements and testosterone concentration

The body weight, body measurements (body length, front-leg length, rear-leg length and chest circumference) and testicular measurements (length, width and circumference) were recorded once a month during the experimental period. Also, Until the experiment's conclusion (the lambs were 13 months old), blood samples were drawn from them once a month at 10:00 AM via jugular vein puncture. Within an hour of collection, plasma was separated by centrifugation at 3000 rpm for 15 minutes. The resulting plasma was then put into a sterile Eppendorf tube and kept at -20ºC until hormone analysis to determine the concentration of the hormone testosterone.

Statistical analysis

The software program SPSS version 24.0 (SPSS Inc., Chicago, Illinois, USA) was used to conduct the statistical analyses. Multivariate analysis of variance (general linear model, GLM) was used to evaluate the data, which are shown as Means ± SEM. Duncan's multiple range test was used to compare the means. (Duncan, 1955).

RESULTS AND DISCUSSION

The results obtained in Table (1) showed that body weight of Sohagi ram lambs was increased gradually ($P < 0.05$) with advancing in age until the end of the experiment (13 months of age), the average initial body weight of ram

lambs was 23.13 kg which increased gradually until it reached 46.63 kg at 13 months of age. In the same line, all body measurements of ram lambs increased gradually ($P < 0.05$). In the beginning of the experiment, body length, front-leg length, rear-leg length and chest circumference were 47.38, 46.38, 53.25 and 66.38 cm, respectively and reached 62.63, 63.75, 68.50 and 87.38 cm, respectively at 13 months of age. Similar results were observed by Maksimović et al. (2016) who found that body weight of male lambs showed a linear increase ($P < 0.05$) from 3 to 13 months of age. Also, Al-kawmani et al. (2014) reported that mean body weight of Najdi ram lambs increased at a constant rate, from 1st month of age and reached a maximum value at the age of 9 months. In the same line, Elmaz et al. (2007) noticed that body weight of male lambs showed a linear increase ($P < 0.05$) post weaning from 2 to 14 months of age. Belibasaki and Kouimtzis (2000) supported these findings and explained that body weight is one of the most commonly used selection criteria as it is considered that attainment of sexual maturity in rams is more related to body growth than to chronological age.

Table 1: Development body weight and body measurements of sohagi ram lambs

Age	**Body measurements (cm)**				
	Body weight	Body length	Front-leg length	Rear-leg length	Chest circumference
5th month	$23.13^{g}\pm1.02$	$47.38^{h}\pm1.10$	$46.38^{g}\pm1.67$	$53.25^{f}\pm1.56$	$66.38^{f}\pm1.13$
6th month	$25.56^{fg}\pm0.99$	$49.13^{gh}\pm0.90$	$49.50^{f}\pm1.04$	$56.50^{e}\pm0.91$	$70.75^{e}\pm0.92$
7th month	$29.38^{ef}\pm1.23$	$51.50^{fg}\pm0.94$	$53.00^{e}\pm0.68$	$60.00^{d}\pm0.50$	$75.00^{d}\pm1.02$
8th month	$32.63^{de}\pm1.43$	$53.25^{ef}\pm1.05$	$55.50^{de}\pm0.53$	$63.25^{c}\pm0.56$	$79.38^{c}\pm1.44$
9th month	$36.31^{d}\pm1.66$	$55.38^{de}\pm0.75$	$57.50^{cd}\pm53$	$64.50^{bc}\pm0.98$	$80.00^{c}\pm1.46$
10th month	$40.44^{c}\pm1.63$	$57.38^{cd}\pm0.53$	$59.75^{bc}\pm0.84$	$64.63^{bc}\pm1.03$	$83.75^{b}\pm1.13$
11th month	$41.88^{bc}\pm1.30$	$59.75^{bc}\pm0.82$	$60.75^{b}\pm0.41$	$66.13^{abc}\pm0.64$	$86.00^{ab}\pm0.59$
12th month	$44.80^{ab}\pm1.45$	$60.63^{ab}\pm0.84$	$61.38^{ab}\pm0.65$	$66.38^{ab}\pm0.73$	$86.63^{ab}\pm0.75$
13th month	$46.63^{a}\pm1.35$	$62.63^{a}\pm0.96$	$63.75^{a}\pm0.96$	$68.50^{a}\pm1.09$	$87.38^{a}\pm0.78$
P value	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**

^{a,b,c,d,e,f,g,h} mean values with the same letter in the same column indicated significant different ($P<0.05$).

It is evident that there was a slight increase in testosterone concentration during the first three months of the experiment (5, 6 and 7 months of age; 4.18, 4.25 and 4.31 ng/dL, respectively), then it began to increase suddenly ($P < 0.05$) during the next two months (8 and 9 months of age; 5.28 and 5.51 ng/dL, respectively), afterwards it decreased again during the 10th month of age (5.03 ng/dL). Beginning of the 11th month of age, there was a second increase ($P < 0.05$) in testosterone concentration (5.68 ng/dL), and it stabilized at its highest level during the 12th and 13th months of age (6.21 and 6.27 ng/dL, respectively) (Table 2). Similarly, Maksimović *et al.* (2016) observed that the testosterone concentration increased linearly between the ages of 3 and 7 months, then decreased between 9 and 11 months, before increasing again at 13 months. Moreover, the obtained results were confirmed in earlier study by Ungerfeld and Gonzalez-Pensado (2008), showing an increase in the testosterone concentration with age. Preston *et al.* (2012) reported that the production of testosterone changed during the life of rams, with increasing levels of hormones from birth until they reach full sexual maturity. The results obtained in Table (2) showed that all testicular measurements of ram lambs increased gradually ($P < 0.05$). In the beginning of the experiment, test length, width and scrotal circumference were 9.50, 7.13 and 23.13 cm, respectively and reached 13.50, 11.75 and 28.38 cm, respectively at 13 months of age.

Table 2: Development of testicular measurements and testosterone concentration of sohagi ram lambs

Age	Testosterone concentration	**Testicular measurements**		
		Test Length	Test width	Scrotal circ.
5th month	4.18^{c}±0.10	9.50^{e}±0.33	7.13^{f}±0.40	23.13^{f}±0.61
6th month	4.25^{c}±0.21	10.25^{de}±0.16	8.25^{e}±0.16	24.50^{e}±0.46
7th month	4.31^{c}±0.03	11.00^{cd}±0.19	9.00^{d}±0.19	25.88^{d}±0.40
8th month	5.28^{b}±0.33	11.88^{bc}±0.30	9.75^{c}±0.25	26.38^{cd}±0.38
9th month	5.51^{ab}±0.41	12.13^{b}±0.40	10.13^{c}±0.23	26.75^{bcd}±0.31
10th month	5.03^{bc}±0.27	12.25^{b}±0.53	10.50^{bc}±0.27	27.25^{abc}±0.37
11th month	5.68^{ab}±0.36	12.88^{ab}±0.44	11.00^{ab}±0.19	27.75^{ab}±0.37
12th month	6.21^{a}±0.35	13.00^{ab}±0.50	11.38^{a}±0.26	28.13^{a}±0.40
13th month	6.27^{a}±0.37	13.50^{a}±0.38	11.75^{a}±0.25	28.38^{a}±0.32
***P* value**	0.001	0.001	0.001	0.001

^{a,b,c,d,e,f} mean values with the same letter in the same column indicated significant different (P<0.05).

Maksimović *et al*. (2016) studied testicular measurements of ram lambs and reported that the scrotal circumference's lowest average values were recorded at three months of age, while its maximum values were recorded at thirteen months. According to a prior study, sheep's testicular measures increased gradually and linearly between the ages of three and seventeen months. (Salhab *et al*., 2001). In addition, according to other accounts, the scrotal circumference and testicular length and width increased gradually and quickly between the ages of three and six months. The increase in testicular size indicated that the lambs were at a stage of rapid sexual development. (Emsen, 2005; Ülker *et al*., 2005). Table 3 shows Pearson correlations among testosterone concentration and both growth performance and testicular measurements in Sohagi ram lambs. The concentration of testosterone and all other measurements studied have a strong and positive correlation (P 0.01). This means that with advancing in age of Sohagi ram lambs, the testosterone hormone concentration increases, which is strongly related to the extent of development in the growth and dimensions of the body. These results were agreement with those found by Maksimović *et al*. (2016) who found a moderately positive correlation between the testosterone level and both body weight and scrotal circumference (r = 0.40 and 0.52, respectively) and a highly positive correlation between body weight and scrotal circumference (r = 0.81). In another study by Zarkawi and Salhab (2008), A much stronger relationship with a correlation coefficient of up to 0.95 (P < 0.0001) was found in male lambs during the first 10 months of life. On the other hand, Salhab *et al*., (2001) found that the body weight of growing rams had a stronger correlation with different testicular parameters than age.

Table 3: The Correlation between testosterone concentration and other studied measurements of sohagi ram lambs

Correlation	Testosterone conc.	Body weigh t	Body lengt h	Front-leg length	Rear-leg lengt h	Chest circ.	Test length	Test widt h	Scrotal circ.
Testosterone conc.	1	0.676**	0.563**	0.520**	0.595**	0.616**	0.488**	0.704**	0.506**
Body weight		1	0.833**	0.866**	0.790**	0.850**	0.708**	0.771**	0.802**
Body length			1	0.866**	0.790**	0.850**	0.708**	0.771**	0.802**
Front-leg length				1	0.899**	0.869**	0.762**	0.799**	0.695**
Rear-leg length					1	0.846**	0.733**	0.788**	0.679**
Chest circ.						1	0.637**	0.892**	0.792**
Test length							1	0.737**	0.583**
Test width								1	0.756**
Scrotal circ.									1

**. Correlation is significant at the 0.01 level (2-tailed).

CONCLUSION

In conclusion, findings of this work show that there is an indisputable relationship between testosterone concentration and both body weight and testes measurements of Sohagi ram lambs. Therefore, measurements of body weight and testes can be used as reliable predictors tool in the selection of breeding rams before lambs reach sexual maturity.

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