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Research Article

Comparison of Plasma Testosterone, Thyroid Levels, and Semen Characteristics of Local and Cross of Improved Awassi Strains in Jordan

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ABSTRACT

This study conducted to evaluate semen quality and plasma testosterone (T), tetra-iodothyronine (T_4), and tri-iodothyronine (T_3) concentrations for different strains of Awassi sheep of different ages in Jordan. Physical traits, semen characteristics and blood samples were assessed in 12 local Awassi rams (6 matures and 6 yearlings) and the 7 crosses of improved Awassi rams (4 matures and 3 yearlings) from the beginning of April until the end of September at the Khanasry Station in Jordan. Local Awassi rams had greater (P<0.01) ejaculate appearance (EA) scale (2.66 ± 0.14 and 2.00 ± 0.19), mass motility (MM) (75.8 ± 1.2% and 70.2 ± 1.6%) and higher (P<0.001) live sperm percent; higher (P<0.05) sperm concentration and (SCN) progressive motility (PM) than crosses of improved Awassi. Local Awassi rams had lower (P<0.001) primary (PAb) and secondary (SAb) abnormal sperm than crosses of improved Awassi. Mature rams had a greater (P<0.05) ejaculate volume (EV), EA scale, SCN and live sperm percent than yearlings. Yearling rams had greater (P<0.001) plasma T_3 (2.05 nmol/L) than mature (1.75 nmol/L) rams. Weekly variations were significantly (P<0.01) different from both strains for some of semen characteristics and blood parameters with fluctuations in different trends. This study indicates that cross breeding of local Awassi with improved Awassi did not improve semen quality and quantity of Awassi sheep in Jordan

Key Words: Ram, semen, age, testosterone, thyroid, season

ÖZET

ÜRDÜN'DE YEREL VE ÇAPRAZ ISLAH ÇALIŞMALARI YAPILAN İVESİ IRKLARINDA PLAZMA TESTOSTERON, TİROİD DÜZEYLERİ VE SEMEN ÖZELLİKLERİNİN KARŞILAŞTIRILMASI

Bu çalışmada, Ürdün'de farklı yaşlardan İvesi koyunlarına ait farklı kökenlerin semen kalitesi ve plazma testosteron (T), tetra-iodothyronine (T_4) ve tri-iodothyronine (T_3) düzeyleri değerlendirilmiştir. Nisan başından itibaren Eylül sonuna kadar Ürdün'de Khanasry İstasyonu'nda bulunan 12 yerel İvesi koç (6'sı yetişkin ve 6'sı toklu) ve 7 çapraz ıslah çalışması yapılmış İvesi koçuna (4'ü yetişkin ve 3'ü toklu) ait fiziksel incelemeleri, sperm özellikleri ve kan örnekleri değerlendirildi. Yerel İvesi koçlarında, çapraz ıslah çalışmaları yapılan İvesi koçlarına oranla daha geniş (P<0,01) ejakulat varlığı (EV) skalası (2,66 ± 0,14 ve 2,00 ± 0,19), kitle motilitesi (KM) (%75,8 ± 1,2 ve %70,2 ± 1,6) ve daha yüksek (P<0,001) canlı sperm yüzdesi; daha yüksek (P<0,05) sperm konsantrasyonu (SK) ve progresif

motilite (PM) saptanmıştır. Yerel İvesi koçlarında çapraz ıslah çalışmaları yapılan İvesi koçlarına oranla düşük (P<0,001) primer (PAb) ve sekunder (SAb) anormal sperm oluşumu belirlenmiştir. Yetişkin koçlarda toklu koçlardan daha geniş (P<0,05) ejekulat hacmi (EH), EV skalası, SK ve canlı sperm yüzdesi saptanmıştır. Toklu koçlarda yetişkin koçlardan (1,75 nmol/L) daha yüksek (P<0,001) plazma T_3 seviyesi (2,05 nmol/L) belirlenmiştir. Haftalık varyasyonlara bakıldığında her iki ırkta sperm özellikleri ve kan parametrelerinde anlamlı (P<0,01) farklılıklar saptanmıştır. Bu çalışma ile Ürdün'de yerel İvesi ırkı ile ıslah çalışmaları yapılan İvesi ırkının birlikte yetiştirilmesinin semen kalitesini ve miktarını etkilemediği belirlenmiştir.

Anahtar Kelimeler: Koç, semen, yaş, testosteron, tiroid, mevsim

Introduction

Awassi is the main breed of sheep in Jordan that has coarse wool, large fat tail, and used for milk, meat and wool production (Kridli et al., 2007; Tabbaa et al., 2006b). The normal breeding season for Awassi sheep occurs between June and September (Zarkawi, 2001). Some of the countries introducing improved Awassi used it as an improver strains or by crossing with local breed (Gursoy et al., 2001). Improved Awassi is associated with considerable improvement in milk production and weaning weight (Gursoy et al., 2001). Recently, improved Awassi ewes and rams were imported to Jordan to upgrade the local Awassi.

Semen quality is one of the major factors that limit male reproductive efficiency (Kridli et al., 2007). Laboratory assays had developed to evaluate the various characteristics of semen, with the expectation that the analysis provides some indications of potential fertility from semen traits. Computer assisted sperm analysis (CASA) gives much more detailed results that are less changed by errors than the manual microscopic observation and it supports an objective and accurate assessment of different sperm characteristics as motility, concentrations, and velocity (Robayo et al., 2008).

In ovine species, hormonal variation affects productive performance (Todini, 2007). Endocrine hormones may be important as predictors of adult sperm production (Langford et al., 1998). Testosterone (T) is the primary male hormone that is responsible for male characteristics, semen production, spermatogenesis, and sexual behavior (Asadpour et al., 2008). Testosterone concentrations vary according to breed, nutrition level, season, age, external stimulants such as behavior of ewes, odor of ewes and ewe estrous manifestation (Zamiri and Khodaei, 2005). Therefore, the ability to determine T production capacity in the testes has a major role in the assessment of sire fertility (Asadpour et al., 2008). In addition, Thyroid hormones seem to have a key role in regulating seasonal breeding in sheep (Souza et al., 2002). Researchers observed marked seasonal variations in plasma thyroid hormone concentrations, associated with semen quality and quantity changes throughout the year (Todini, 2007). The involvement of thyroid hormones in seasonal breeding and in regulating the process of the growth, lactation, reproduction, and the general health was well studied (Alwan, 2009; Todini, 2007). Thyroid gland secretes mostly the tetra-iodothyronine (thyroxin) (T_4) which is converted to tri-iodothyronine (T_3) by deiodination, prior to interaction with the target cells, to exert its biological effects (Todini, 2007).

The objectives of this study were to evaluate semen quality and plasma T, T_4, and T_3 concentrations for different strains of Awassi sheep of different ages before and throughout the normal breeding season in Jordan in order for early diagnose disorders and problems, which would adversely affect the reproductive ability of rams.

Materials and Methods

Study Area

The study was conducted during the period from onset of April to the end of September 2010 at the Khanasry Station (32º30' N 59º35' E) for livestock Research (KSLR) belonging to the National Center for Agriculture Research and Extension (NCARE).

Animals

Nineteen healthy Awassi rams were available of different ages (mature 2-6 years old, and yearlings 12-22 month old) and from two strains (Local Awassi and cross of Improved Awassi) used in the study. Improved Awassi is associated with considerable improvement in milk production and weaning weight by selection. For instance, were local Awassi ewes bred to improved rams and male offspring are now being evaluated. Rams kept in one open barn with free access to shade, water and mineral blocks at the KSLR under the same management conditions. Rams housed separated from females from the onset of the study until the end. Rams fed according to NRC recommendation. They were fed 1.5 kg per head per day concentrates (65-70% barley, 15-20% wheat brans, and 15% soybean meal) and 0.5 kg per head per day roughage (shredded wheat straw and alfalfa).

Physical traits

On the day of evaluation, animals were weighed (BW) before access to feed and water, and body condition scored (BCS), using score system 0-5 (0 being emaciated and 5 being obese) recorded. In addition, the scrotum circumference (SC) measured with a flexible tape (±0.1 cm) around the widest point of the scrotum for each ram.

Semen collection and evaluation

Semen samples were collected every 2 weeks using a battery-operated electro-ejaculator (Bailey Ejaculator, USA) and a series of short electrical stimuli (approximately 5-8 seconds). Ejaculate volume (EV) and ejaculate appearance (EA) scale were determined immediately after collection from a transparent graduated tube. The EA scale was ranked as watery (0), cloudy (1), milky (2), creamy (3) and thick creamy (4). Semen samples were placed in a water path (37±2 ^{o}C) immediately after collection, and then samples carried immediately to the evaluation in Faculty of veterinary medicine/ Jordan University for Science and Technology within 20 minutes by car. Water temperature reached 33 ± 2 ^{o}C when arrived to the university. At the university, a CASA system (HTM-IVOS, Hamilton Thorne Research, Beverly, MA, USA) was used to evaluate the semen. Computer assisted sperm analyzer was programmed to take readings from twenty fields for each slide.

The evaluation of semen was performed using a two-chamber slide with a 20 µm deep (Microcell; Conception Technologies, San Diego, CA, USA). The chamber was loaded with a 10µl semen suspension. The commonly estimated CASA parameters include: (a) Sperm concentration (SCN) was determined by diluting the semen in sodium citrate saline (3%) 1:500 or 1:600 (Semen: diluents), (b) Mass motility (MM) (ranging from 0%= total immobility to 100%= rapid wave motion), (c) Progress Motility (PM) (d) Curvilinear velocity (VCL) (measured in µm/s), which is the average velocity of motile sperms over distance traveled, including all deviations of sperm head movement, (e) Average path velocity (VAP) (measured in µm/s), which is sperm's velocity over a calculated, smoothed path, (f) Straight line velocity (VSL) (measured in µm/s), which is average the velocity calculated using a straight line distance between the beginning and the end of the sperm track, (g) Straightness (STR), which is the proportion of straight motile sperms as ratio of VSL/VAP×100 and (h) Linearity (LIN), which is the proportion of linearly motile sperm as ratio of VSL/VCL×100. The VCL, VAP, VSL, STR, and LIN are called Kinematics parameters for semen. Moreover, the percentage of live sperm, primary (PAb) and secondary (SAb) abnormalities were estimated by viewing 200 spermatozoa under oil lens (1000x) using Eosin-Nigrosin stain for each sample at the University of Jordan in the reproduction and artificial insemination lab.

Blood collection and hormonal assay

Blood samples (6 ml) were collected by jugular veinipuncture every 2 weeks from each ram. Plasma was harvested by centrifugation of blood at 3000 rpm for 15 minutes immediately after collection. Plasma was stored in plasma vials at -20 ^{o}C until analysis for "T" hormone, "T_4, and T_3" hormones concentrations using Radioimmunoassay (RIA) kit (Immunotech,

France). The sensitivity was 0.025 ng/ml for plasma T; 13 nmol/L for plasma T_4 and 0.3 nmol/L for plasma T_3. The intra- and inter-assay coefficients of variation were 7.8 and 8% for plasma T; 2.8 and 3.6% for plasma T_4; 4.1 and 5.5% for plasma T_3 respectively.

Statistical analysis

Split plot design was used for analysis of variance to study the effect of age group, breed, week, and their interactions on BW, BCS, SC, semen characteristics, T, T_4 and T_3 hormones. The General Linear Model (GLM) procedure of the Statistical Analysis System (SAS, 2004) was used to accomplish different analysis. Means of significant effects (P<0.05) were compared using t-test.

Results

Means for BW, BCS, and SC are presented in Table 1. The mean BW, BCS and SC are similar for both strains. Mature rams recorded higher (P<0.001) BW, BCS and larger (P<0.01) SC than yearling rams. There was a gradual increase in SC with higher (P<0.01) values in Local Awassi during the study period (Figure 1).

Semen parameters are shown in Table 1. Ejaculate volume did not differ between the two strains. Ejaculate volume ranged from 0.3 to 2.1 ml for local Awassi and 0.3 to 1.8 ml for cross of improved Awassi. Local Awassi rams were better (P<0.01) in EA scale, MM, and higher (P<0.001) live sperm percent and higher (P<0.05) in SCN and PM while lower (P<0.001) in PAb and SAb than cross of improved Awassi.

Mature rams had a higher (P<0.05) EV, SCN, PM and live sperm percent than yearling rams. There was a weak positive correlation (P<0.01) between EV and SC (r=0.27). Ejaculate appearance scale was higher (P<0.05) in mature (2.57 ± 0.17) (creamy color) than yearlings (2.09 ± 0.17) (milky color). There was a strong positive correlation (P<0.01) between SCN and EA (r=0.92) scale. The highest percentage for MM (P<0.01) were found in yearling compared with mature rams.

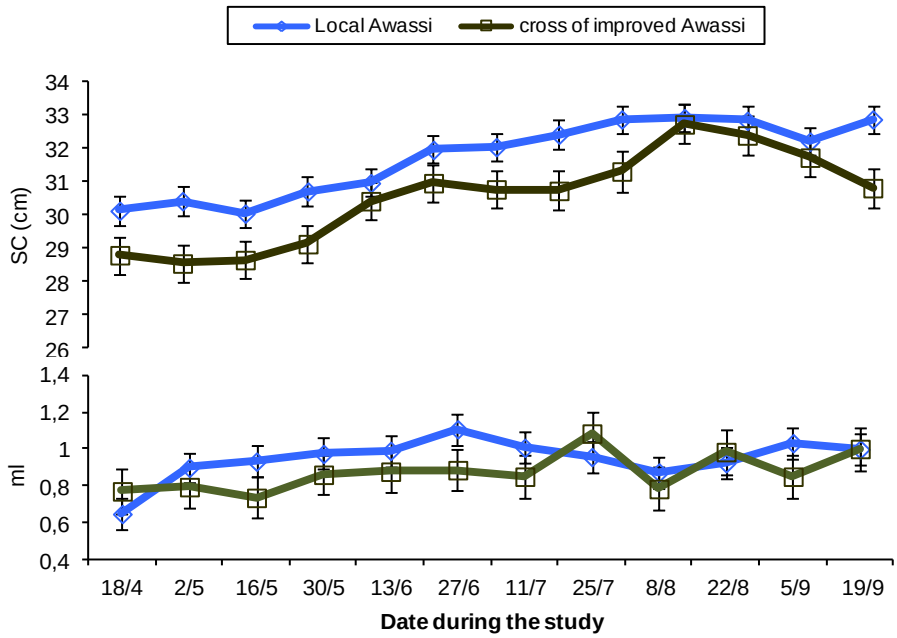

Figure 1. Biweekly variations in scrotal circumference and ejaculate volume according to different strains of Awassi rams during the study period.

Şekil 1. Çalışma süresince İvesi koçlarına ait farklı kökenlerin skrotum çevresi ve ejekulat hacminin iki haftalık varyasyonları.

Table 1. Least square means (±SEM) for physical examination measures and semen characteristics for two different strains of Awassi rams and ages and their interaction during study period[1].

Tablo 1. İki farklı kökenden olan İvesi koçlarının ve farklı yaşlardaki koçların çalışma periyodu sırasında fiziki muayene ve semen özelliklerinin en küçük kare farkı (± SEM)[1].

Factors	N	BW Kg	BCS 0-5	SC cm	EV ml	EA 0-4 score	SCN $\times 10^9$	MM %	PM %	LIVE %	PAb %	SAb %
CV%		30.3	14.7	14.1	34	47.8	42.4	23.1	55.2	16.4	30.2	33
Strain groups		N.S.	N.S.	N.S.	N.S.	**	*	**	*	***	***	***
Local Awassi	12	68.6±3.5	3.4±0.1	31.7±1.0	0.95±0.04	2.66±0.14^a	3±0.1^a	75.8±1.2^a	43.9±2.0^a	68.4±0.7^a	11.5±0.4^b	8.9±0.2^b
Cross of improved Awassi	7	68.4±4.8	3.3±0.1	30.5±1.4	0.88±0.05	2.00±0.19^b	2.5±0.1^b	70.2±1.6^b	35.7±2.9^b	58.2±1.0^b	15.6±0.5^a	11.2±0.3^a
Age groups		***	***	**	*	*	*	**	*	*	N.S.	N.S.
Yearling	9	49.9±4.2^b	2.9±0.1^b	28.4±1.2^b	0.85±0.05^b	2.09±0.17^b	2.5±0.1^b	75.5±1.4^a	43.3±2.5^a	61.9±0.8^b	13.8±0.5	10.1±0.3
Mature	10	87.1±4.1^a	3.7±0.1^a	33.9±1.2^a	0.97±0.05^a	2.57±0.17^a	3±0.1^a	70.6±1.4^b	36.3±2.5^b	64.7±0.8^a	13.3±0.5	10.0±0.3
Age × Strain		N.S.	+	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Yearling local Awassi	6	54.1±4.9	3.1±0.1^b	29.5±1.4	0.85±0.05	2.48±0.19	2.8±0.2	79.4±1.6	48.9±2.8	66.8±1.0	11.6±0.6	8.7±0.4
Yearling cross of improved Awassi	3	45.8±6.9	2.8±0.1^c	27.3±2.0	0.84±0.08	1.70±0.28	2.2±0.2	71.5±2.3	37.7±4.1	57.1±1.4	16.1±0.8	11.5±0.5
Mature local Awassi	6	83.2±4.9	3.7±0.1^a	34.0±1.4	1.04±0.05	2.84±0.19	3.1±0.2	72.2±1.6	38.9±2.8	70.1±0.9	11.4±0.5	9.2±0.3
Mature cross of improved Awassi	4	91.0±6.6	3.8±0.1^a	33.7±1.9	0.99±0.07	2.30±0.27	2.8±0.2	68.9±2.3	33.8±4.1	59.3±1.3	15.1±0.7	10.9±0.5

N.S.: Not significant, +: P<0.1, *: P<0.05 , **: P<0.01, ***: P<0.001,

[1] :The study period was extended from onset of the April until the end of September,

CV : Coefficient of variation, N :number of Animals, BW :body weight, BCS :body condition score, SC :scrotal circumference, EV :ejaculate volume, EA :ejaculate appearance, SCN : sperm concentration, MM :mass motility, PM :progressive motility, LIVE :Live sperm percent, PAb :primary abnormality percent, and SAb : secondary abnormality percent.

Table 2. Least square means (±SEM) for Kinematics parameters of semen for two different ages and strains during study period[1].

Tablo 2. Çalışma süresince iki farklı yaş ve köken için semen Kinematiği parametrelerinin en küçük kare farkı (± SEM)[1].

Factors	N	VAP (μm/s)	VSL (μm/s)	STR %	LIN %
CV%		59.6	68.4	10.9	31.5
Strain groups		+	+	N.S.	N.S.
Local Awassi	12	155.9±8.8[a]	132.1±8.1[a]	83.8±0.8	53.5±1.6
Cross of improved Awassi	7	132.0±12.5[b]	107.7±11.6[b]	83.4±1.1	52.6±2.4
Age groups		N.S.	N.S.	N.S.	N.S.
Yearling	9	144.2±10.9	120.6±10.0	84.2±1.0	53.3±2.0
Mature	10	143.7±10.7	119.2±10.0	82.4±1.0	51.8±2.0
Age × Strain		N.S.	N.S.	N.S.	N.S.
Yearling local Awassi	6	152.3±12.4	130.0±11.5	85.1±1.1	54.4±2.3
Yearling cross of improved Awassi	3	136.1±17.9	111.3±16.6	83.3±1.6	52.1±3.4
Mature local Awassi	6	159.5±12.4	134.3±11.5	81.5±1.1	50.5±2.3
Mature cross of improved Awassi	4	127.9±17.5	104.1±16.3	83.4±1.6	53.0±3.3

N.S.: Not significant, + (P<0.1),

[1]The study period was extended from onset of the April until the end of September,

CV: Coefficient of variation, N: number of Animals, VAP: Average path velocity, VSL: straight line velocity, STR: straightness, and LIN: linearity.

Table 3. Least square means (±SEM) for hormone concentrations for two different strains and ages during study period[1].

Tablo 3. Çalışma süresince iki farklı yaş ve köken için hormon konsantrasyonlarının en küçük kare farkı (± SEM) [1].

Factors	N	T ng/ml	T_4 nmol/L	T_3 nmol/L
CV%		72.5	31.8	23.4
Strain groups		N.S.	N.S.	+
Local Awassi	12	3.08±0.26	61.82±4.06	1.98±0.05[a]
Cross of improved Awassi	7	3.05±0.37	61.87±5.70	1.82±0.07[b]
Age groups		+	N.S.	***
Yearling	9	2.67±0.32[b]	63.43±4.06	2.05±0.06[a]
Mature	10	3.46±0.32[a]	60.26±4.92	1.75±0.06[b]
Age × Strain		N.S.	N.S.	N.S.
Yearling local Awassi	6	2.62±0.37	67.11±5.74	2.17±0.07
Yearling cross of improved Awassi	3	2.73±0.53	59.75±8.11	1.94±0.10
Mature local Awassi	6	3.53±0.37	56.54±5.73	1.80±0.07
Mature cross of improved Awassi	4	3.38±0.52	63.99±7.98	1.70±0.10

N.S.: Not significant, +: (P<0.1), ***: (P<0.001),

[1]: The study period was extended from onset of the April until the end of September,

CV: Coefficient of variation, N: number of Animals, T: plasma testosterone hormone, T_4: Plasma tetra-iodothyronine hormone and T_3: plasma tri-iodothyronine hormone.

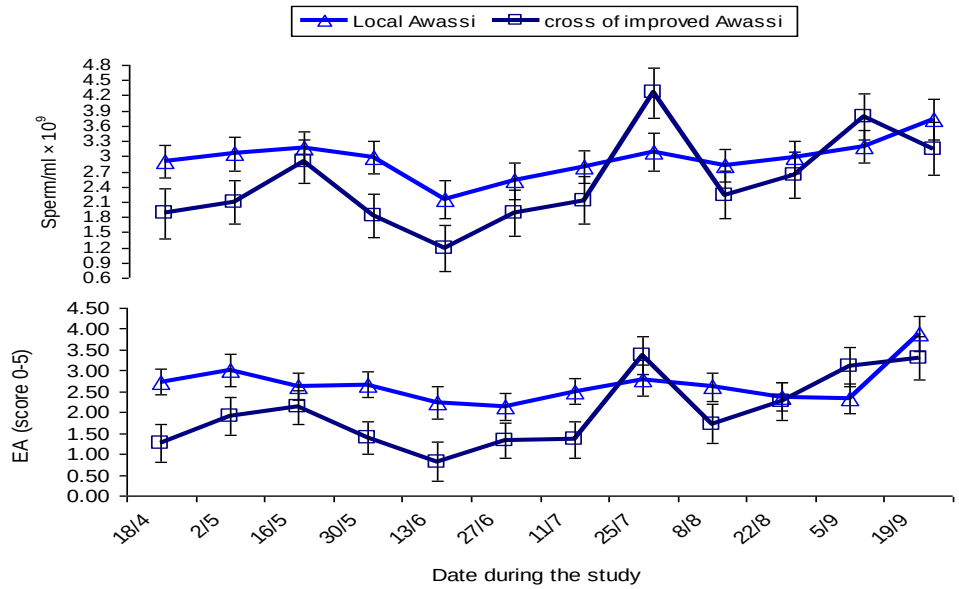

Figure 2. Biweekly variations in ejaculate appearance and sperm concentration for different strains of Awassi rams during the study period.

Şekil 2. Araştırma sürecinde farklı düzeyde İvesi genotipi taşıyan koçların ejakulat görünümü ve sperm konsantrasyonlarının iki haftalık değişimleri.

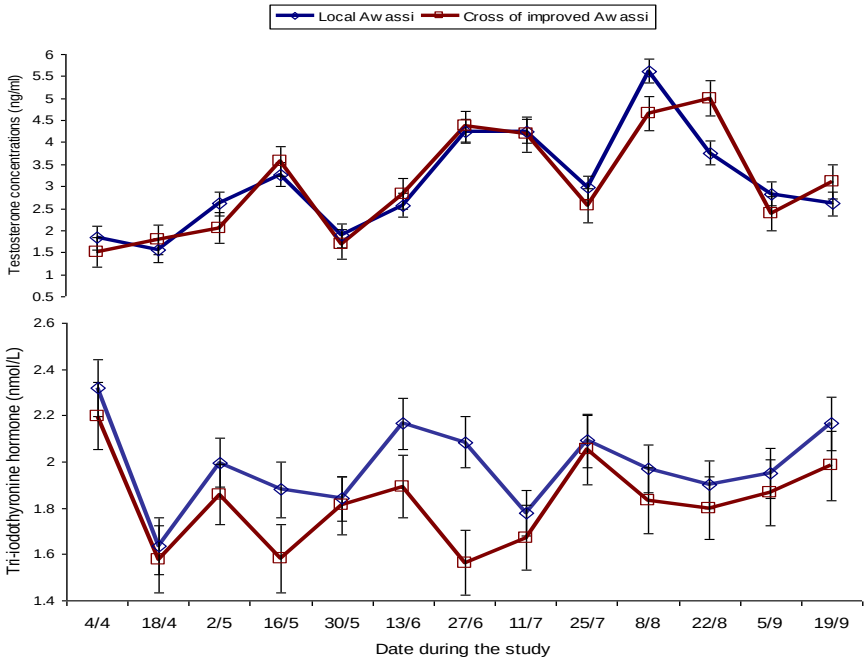

Figure 3. Biweekly variations in plasma testosterone and tri-iodothyronine hormone concentrations for different strains of Awassi rams during the study period.

Şekil 3. Çalışma süresince İvesi koçlarına ait farklı kökenlerin plazma testosteron ve tri-iyodotironin hormon konsantrasyonlarının iki haftalık varyasyonları.

The EV was steadily increased to reach highest value (1.1 ml) during breeding season (July) with some drops in August month (0.9 ml) (Figure 1). At the start of the study (April), the EA scale increased for both strains with higher ($P<0.01$) appearance scale in local Awassi during the study period, then there was some decrease in EA scale with deeper drop for cross of improved Awassi (Figure 2). The overall picture of the trend of SCN was to increase, although there was high fluctuation in SCN with higher ($P<0.01$) SCN in local Awassi in some points of time as shown in Figure 2.

There was no effect of strains and ages on Kinematic parameters as shown in Table 2. The Kinematics parameters did not change over the time in any of the four groups of ram.

There was no effect ($P>0.1$) of strain on plasma T, T_4 and T_3 concentrations (Table 3). The T tended to be influenced ($P<0.1$) by age, with higher value for mature than that of yearlings. There was a weak positive correlation ($P<0.01$) between SC and T ($r=0.38$). The plasma T_4 was not affected by age of rams while plasma T_3 was higher ($P<0.001$) in yearlings than mature rams (Table 3).

There was a fluctuation, with no differences in plasma T between the two strains during the study period except in August as shown in Figure 4. However, the overall trend was to increase T concentration during the breeding season. On the other hand, there was a variation ($P<0.01$) in plasma T_3 concentration over study period with no clear trend with some of decreases during breeding season (Figure 4).

Discussion

The mean BW, BCS and SC are similar for both strains. The BW and BCS vary among breeds of sheep (Kridli et al., 2006). Scrotal circumference is different between breeds of rams and among individuals of the same breed (Langford et al., 1998). The differences in SC due to breed effect in other studies were significant and could be related to breed size and the location of rearing rams (Zamiri and Khodaei, 2005).

Mature rams recorded higher BW, BCS and SC than yearling rams. This result is very similar to what was previously obtained for local Awassi in Jordan, where BW was higher for mature rams than that for yearlings (Tabbaa et al., 2006a and 2006b). Unlike this study, there was a decrease in SC during the non-breeding season (Tabbaa et al., 2006a and 2006b). This difference may be related to differences in breed, and location of rearing at the breeding season.

The lack of significance among strains with respect to EV may be due to the use of electrical stimulation for semen collection. The use of electro ejaculator increases EV due to stimulating the accessory sex glands then increase the amount of seminal fluids in the ejaculate thus decreases semen concentration (Gundogan, 2007). The Local Awassi rams were better in SCN than cross of improved Awassi. This result is in agreement with Taha et al. (2000) who found a significant difference between Awassi (imported from Syria) (5.2×10^9 sperm/ml) and local Awassi (5.4×10^9 sperm/ml) in Egypt when used artificial vagina. The mean abnormality percent was 22.7% for both strains. Taha et al. (2000) reported similar results; they found that the mean abnormal sperms percent was 21.1% in local Awassi and Awassi imported from Syria in Egypt. Abnormal spermatozoa were influenced by genotype and sampling day and method of collection (Kridli et al., 2006).

Mature rams were higher in EV, EA scale, SCN and live sperm percent while yearling rams were higher in MM and PM. Similarly, Tabbaa et al. (2006a) reported that mature rams had greater EV and EA scale. Mature rams have more viable sperm than yearlings because they have largest testes, ejaculate more live sperm and better in SCN, but fewer sperm abnormalities have little to do with it.

Suffolk sperm motility patterns evaluated by CASA can be characterized as relatively rapid (VAP, VSL > 100 μm/s) and following a linear trajectory (LIN > 50%) (Robayo et al., 2008). Therefore, sperm motility in local Awassi is

characterized as rapid as and more linear than cross of improved Awassi.

There was no effect of strain on plasma T, T_4, T_3 concentrations. In contrast, plasma T concentrations may differ between pure and crossbred rams and among breeds of sheep (Kridli et al., 2006). There was no differences in plasma T_3 concentration between Awassi (imported from Syria) (2.22 nmol/L) and Awassi (2.11 nmol/L) rams in Egypt (Taha et al., 2000). The mean plasma T_3 concentrations were 1.28 nmol/L in mature Daglic fat tailed and 1.46 nmol/L in mature Chios rams (Gundogan, 2007).

Plasma T_3 was higher in yearlings than matures ram. This result is in agreement with Alwan (2009) who reported that mean plasma T_3 concentration decrease as age of rams progresses. The growing animals showed high level of thyroid hormones compared with mature animals (Alwan, 2009). There was a weak positive correlation ($P<0.01$) between T_4 and T_3 ($r=0.33$).

The overall trend was to increase T concentration during the breeding season for both strains. In other study, Taha et al., (2000) found that plasma T concentration was higher during summer month than other months of the year. The accessory sex glands being more active when plasma concentration of T is high during the breeding season and less active when plasma T concentrations are low during non-breeding season (Corteel, 1977). There was no clear trend of Plasma T_3 with some of decreases during breeding season for both strains. Plasma T_3 concentration in rams tended to vary during the 24 h period with highest concentrations occurring in the afternoon and lowest concentrations in the early morning hours (Souza et al., 2002).

Conclusion

Local Awassi rams are superior to cross of improved Awassi rams in semen characteristics during the normal breeding season in Jordan except some of a better performance for cross of improved than local Awassi at the end of normal breeding season in Jordan. So, further study is required to extend the study period after the month of September. Moreover, mature rams have heavier body weights and larger scrotal circumferences than yearling and are capable of producing larger ejaculate volumes, sperm concentrations, live sperm percent and better sperm appearance scale. Tri-iodothyronine hormone (T_3) is higher in yearling than mature.

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