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Effects of season and breed on the reproductive performance of sheep

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ABSTRACT The aim of the current study was to compare the effects of season and breed on the reproductive performance of male and female sheep using 12 rams and 318 ewes of Assaf and Awassi breeds under the seasonal environmental condition of United Arab Emirates for two years. The blood level of testosterone hormone was measured monthly. Semen was collected twice a month from each male using artificial vagina and evaluated for volume, motility, livability, abnormality and concentration. The scrotal circumference and thickness as well as the left testicular length, width, height and volume were measured at one-month intervals. The level of testosterone in Assaf breed was significantly higher in autumn than winter and summer. The scrotal circumference and thickness as well as the left testicular length were significantly higher in Assaf breed than Awassi breed. While, left testicular width and volume were significantly higher in Awassi breed than Assaf breed. Scrotal circumference which was higher in spring and summer than in autumn and winter season in both breeds. The SCC of semen was significantly higher in autumn than in other seasons in both breeds. The sperm abnormality was significantly higher in summer than other seasons in both breeds. The livability was significantly lower in summer in both breeds. Fecundity and prolificacy were significantly higher in Assaf than Awassi breed during autumn season. Assaf breed showed the superior reproductive performance in the autumn season when compared with Awassi breed in the same season and other seasons. The Assaf breed tolerated the climatic conditions in UAE and kept the litter size of 1.72 in comparison to Awassi breed which showed litter size of 1.09. in conclusion, the results showed the superiority of Assaf over Awassi breed and offer a good model of breeding with increased fecundity and prolificacy specially in autumn season.

Keywords: Assaf, Awassi, breed, fertility, seasonal variations, sheep, sperm

INTRODUCTION

The ram is the most important member of the flock, yet often the most neglected. Ram contributes half of the genetics to the flock and his success as a breeder will go a long way towards ensuring a profitable lamb crop. Different farms maintain different breeds of sheep and goat breeds in UAE as per the choice of the owner. Food and

Agriculture Organization (FAO) stated in one of its reports (FAO, 1991) that the genetic potential and productivity of goats and sheep are deteriorating due to indiscriminate type of breeding. This may be minimized by providing sound breeding knowledge to the breeders including the most adapted breed for the Environmental conditions and the breeding seasonality. In the UAE, the climate condition is very adverse during summer months, which can affect semen quality. It is well known that the sexual behavior, semen quality and quantity are the main factors that limit male reproductive efficiency during the year. These factors could vary according to different environmental and physiological factors such as climate (Zarei et al., 2009); latitude, breeding season of the year (Karagiannidis et al., 2000). Semen quality can be affected by breed, age, nutritional factors, environmental factors like ambient temperature, humidity, hours of day light etc. (Al Samarrae, 2009; Moghaddam et al., 2012; Malejane et al., 2014). Multiple ovulations and embryo transfer results are significantly affected by the breed (Swelum et al., 2014). Additionally, the ovarian activity are significantly affected by season (Yu et al., 2017). Selection of young rams for fertility can be accomplished through selecting some important reproductive traits such as age at puberty, body condition score, body growth rate, scrotal circumference, scrotal growth rate And semen quality (Land and Carr, 1975). Various factors affecting ejaculate volume and semen quality have been reported in literature. These include breed, season of the year, age of the male, nutritional status of the animal, reproductive management, skill of the semen collector, responsiveness of the ram, method and the frequency of semen collection (Talebi et al., 2009). Humidity and temperature changes can cause thermal discomfort, resulting in a decrease in food intake and interference with spermatogenesis and semen quality (Kunavongkrit et al., 2005). Level of sexual hormones, affected by climate changes, has a great influence on the physiological chain of events involved in the sexual cycle (Abecia et al., 2012). Testosterone is the hormone responsible for spermatogenesis and sexual behavior, thus the seasonal pattern of testosterone secretion could limit the male reproductive efficiency during some periods of the year (Todini et al., 2007). Testosterone level is correlated positively and significantly with sperm motility and progressive motility (Swelum et al., 2017). It is hypothesized that season and breed can affect the reproductive performance sheep. Therefore, the current study aimed to compare the effects of season and breed (Assaf and Awassi) on the reproductive performance of male and female sheep under the condition of United Arab Emirates.

MATERIALS AND METHODS

The current research was conducted at Baniyas Research Station, Research and Development Division, Development Sector, Abu Dhabi Agriculture and Food Safety Authority, Abu Dhabi, United Arab Emirates for two years. Average daily temperature (°C), humidity % and average sun hours/day in Abu Dhabi are illustrated in Table 1. The experimental protocol regarding the care and handling of animals had been approved by the Ethics Committee of the Research and Development Division, Development Sector, Abu Dhabi Agriculture and Food Safety Authority.

Two sheep breeds (Assaf and Awassi) were included in this study. Animals are maintained under similar feeding and management conditions. Males are kept separated from females in different sheds. Six healthy males from each breed aged 3-5 years were selected for semen evaluation. Within each breed, males of almost the same body weight and body condition score were selected. Males were trained for semen collection using artificial vagina, while ewes in estrus were used as mounts. Blood samples were collected monthly for two years from animals of the different sheep breeds and sent to laboratory to estimate the level of testosterone hormone. Semen was collected twice a month from each male for two years using artificial vagina. Collected semen samples were identified and immediately transferred to the lab to be tested. Macroscopic characteristic of semen (volume) was recorded. Fresh semen samples were used to study the microscopic characteristics of semen. These included, sperm motility (progressive forward motility), live and dead sperms percentage (livability) using eosin nigrosine stain, sperm

Table 1. Average daily temperature (°C), humidity % and average sun hours/month in Abu Dhabi

Season (months)	Autumn (Sep–Nov)	Winter (Dec–Feb)	Spring (Mar–May)	Summer (Jun–Aug)
Average daily temperature °C	34.4 ± 2.5	24.1 ± 1.2	30.8 ± 2.1	40.5 ± 3.1
Humidity %	64.2 ± 3.7	69.2 ± 4.1	48.1 ± 2.9	50.3 ± 4.1
Average sun hours/day	9.6 ± 1.1	8.0 ± 0.4	10.4 ± 1.2	10.9 ± 1.3

abnormality using alkaline methyl violet and sperm concentration using hemocytometer method. The scrotal circumference and thickness as well as the left testicular length, width and height were measured at its maximum dimension in sitting position at one-month intervals for two years using a coulter scrotal tape and caliper. Left testicular volume was calculated using following formula (volume = length × width × height × 0.71).

Three-hundred-eighteen ewes of two sheep breeds (Assaf [n = 168] and Awassi [n = 150]) aged 2-3 years were selected for fertility trial during two years. Estrus synchronization was carried out with the aid of intra-vaginal polyurethane sponges impregnated with 30 mg fluorogestone acetate (FGA; Synchropart®, Ceva Sante, Animale, France). Intra-vaginal sponge was left in the vagina for a 14-day period (Swelum et al., 2015). Rams were joined to ewes in a rate of 1:4 and left together for three weeks. Pregnancy was diagnosed ultrasonography using multi-frequency convex abdominal probe (Model UST-9137C, Aloka, Japan). Number of fetuses were recorded and confirmed at lambing. Pregnancy rate (pregnant ewes detected by ultrasound/matted ewes*100), lambing rate (lambed ewes/inseminated ewes*100), twining rate (ewes lambed twins/pregnant ewes*100), abortion rate (aborted ewes/pregnant ewes*100) fecundity (newborn lambs/inseminated ewes) and prolificacy or litter size (newborn lambs/pregnant ewes) were calculated (Swelum et al., 2018a; Swelum et al., 2018b).

Comparisons among groups were analyzed by repeated measures analysis of variance (ANOVA), using SAS (SAS Institute, Cary, NC, USA, 2000) to evaluate the effect of breed and season. Data were expressed as the mean± standard error. Fertility parameters were evaluated using Chi Square (χ^2) test and expressed as percentages. A difference was considered significant at $p < 0.05$ level.

RESULTS

Effects of season and breed of sheep on testosterone levels are effect presented in Table 2. Regarding the season effect within the same breed, there is no significant effect for season on testosterone level in Awassi breed. While, the level of testosterone in Assaf breed was significantly higher in autumn than winter and summer. Regarding the breed effect within the same season, the level of testosterone was insignificantly differed between Assaf and Awassi breeds during all seasons.

The effects of season and breed of sheep on testicular and scrotal morphometric parameters are presented in

Table 2. Effects of season and breed of sheep on testosterone levels

Breed	Autumn	Winter	Spring	Summer
Assaf	720.83 ± 132.23^{a}	401.92 ± 67.81^{b}	466.92 ± 97.67^{a,b}	397.25 ± 84.77^{b}
Awassi	697.42 ± 136.38	455.08 ± 45.67	547.73 ± 143.74	679.75 ± 127.06

Means ± standard error carrying different capital letters (A, B) within the same column and parameter are significantly differed ($p \leq 0.05$) (Effect of breed).

Means ± standard error carrying different superscript (a, b, c, and d) within the same row and parameter significantly differed ($p \leq 0.05$) (Effect of season).

Table 3. Effects of season and breed of sheep on testicular and scrotal morphometric parameters

Parameter		Autumn	Winter	Spring	Summer
Testicular length	Assaf	13.45 ± 1.08^{A}	13.45 ± 1.10^{A}	13.47 ± 1.07^{A}	13.50 ± 1.13^{A}
	Awassi	13.00 ± 0.76^{B}	12.87 ± 0.73^{B}	12.90 ± 0.70^{B}	12.95 ± 0.65^{B}
Testicular width	Assaf	7.42 ± 0.89^{B}	7.42 ± 0.92^{B}	7.44 ± 0.87^{B}	7.42 ± 0.89^{B}
	Awassi	8.32 ± 0.94^{A}	8.32 ± 0.96^{A}	8.37 ± 0.95^{A}	8.38 ± 0.94^{A}
Testicular hight	Assaf	8.37 ± 1.13	8.37 ± 1.15	8.37 ± 1.13	8.37 ± 1.1
	Awassi	8.65 ± 0.45	8.65 ± 0.49	8.65 ± 0.45	8.65 ± 0.45
Testicular volume	Assaf	597.57 ± 126.0^{B}	597.57 ± 128.9^{B}	599.89 ± 124.1^{B}	600.32 ± 127.1^{B}
	Awassi	667.95 ± 110.57^{A}	661.63 ± 113.6^{A}	666.69 ± 108.3^{A}	670.39 ± 109.0^{A}
Scrotal circumference	Assaf	36.37 ± 0.98^{A,a}	34.53 ± 1.82^{A,b}	34.37 ± 2.25^{A,b}	36.09 ± 0.91^{A,a}
	Awassi	34.92 ± 1.58^{B,a}	32.92 ± 1.97^{B,b}	32.65 ± 1.91^{B,b}	34.89 ± 1.76^{B,a}
Scrotal thickness	Assaf	0.32 ± 0.02^{A}	0.32 ± 0.02^{A}	0.32 ± 0.02^{A}	0.32 ± 0.02^{A}
	Awassi	0.27 ± 0.04^{B}	0.27 ± 0.04^{B}	0.27 ± 0.04^{B}	0.27 ± 0.04^{B}

Means ± standard error carrying different capital letters (A, B) within the same column and parameter are significantly differed ($p \leq 0.05$) (Effect of breed).
Means ± standard error carrying different superscript (a, b, c, and d) within the same row and parameter significantly differed ($p \leq 0.05$) (Effect of season).

Table 3. The scrotal circumference and thickness as well as the left testicular length were significantly higher in Assaf breed than Awassi breed. While, left testicular width and volume were significantly higher in Awassi breed than Assaf breed. About season effect, no effect for season was detected except in scrotal circumference which was higher in spring and summer than in autumn and winter season in both breeds.

Effects of season and breed of sheep on semen quality parameters are presented in Table 4. The volume of semen was significantly higher ($p \leq 0.05$) in autumn followed by winter then summer and spring in Asaaf breed. The volume of semen was significantly higher ($p \leq 0.05$) in autumn followed by summer than spring in Awaasi breed. The SCC of semen was significantly higher ($p \leq 0.05$) in autumn followed by in winter followed by in spring than in summer in Asaaf breed. The SCC of semen was significantly higher ($p \leq 0.05$) in autumn followed by spring and winter than in summer in Awaasi breed. The sperm motility was significantly higher ($p \leq 0.05$) in winter and spring than in summer in Asaaf breed. No significant differences were detected between sperm motility in different season in Awaasi breed. The sperm abnormality was significantly higher ($p \leq 0.05$) in summer than other seasons in both breeds. While the lowest sperm abnormality was detected in autumn in all breed. The sperm livability was significantly lower ($p \leq 0.05$) in summer than other seasons Asaaf breed. The livability was significantly lower ($p \leq 0.05$) in summer than winter and autumn seasons in Awaasi breed.

The effects of season and breed of sheep pregnancy rate, fecundity, litter size and male to female ratio are presented in Table 5. No abortion was recorded. Therefore, the lambing rate was the same of pregnancy rate. Fecundity and prolificacy were significantly higher in Assaf than Awassi breed during autumn season. While, no significant difference was observed during other seasons.

Table 4. Effects of season and breed of sheep on semen quality parameters

Parameter		Autumn	Winter	Spring	Summer
Volume (mL)	Assaf	1.51 ± 0.02^{a}	1.22 ± 0.056^{b}	0.99 ± 0.096^{c}	$1.042 \pm 0.033^{b,c}$
	Awassi	1.45 ± 0.03^{a}	$1.067 \pm 0.039^{b,c}$	0.97 ± 0.047^{c}	1.125 ± 0.035^{b}
SCC ($\times 10^{6}$/mL)	Assaf	3.60 ± 0.03^{a}	$3.30 \pm 0.042^{A,b}$	3.10 ± 0.046^{c}	$2.800 \pm 0.047^{A,d}$
	Awassi	3.60 ± 0.03^{a}	$3.10 \pm 0.065^{B,b}$	3.00 ± 0.047^{b}	$2.60 \pm 0.036^{B,c}$
Motility %	Assaf	$63.08 \pm 0.52^{a,b}$	64.17 ± 0.96^{a}	64.33 ± 1.32^{a}	60.08 ± 0.98^{b}
	Awassi	64.25 ± 0.68	64.33 ± 1.45	63.58 ± 0.39	61.92 ± 0.64
Abnormal %	Assaf	$8.0 \pm 0.76^{B,c}$	$10.0 \pm 0.38^{B,c}$	12.0 ± 0.77^{b}	15.0 ± 0.53^{a}
	Awassi	$10.67 \pm 0.93^{A,b}$	$13.0 \pm 0.65^{A,b}$	11.0 ± 0.47^{b}	16.0 ± 0.80^{a}
Livability %	Assaf	72.83 ± 0.70^{a}	72.33 ± 1.01^{a}	71.50 ± 1.15^{a}	65.83 ± 0.86^{b}
	Awassi	71.83 ± 0.86^{a}	71.67 ± 1.17^{a}	$70.92 \pm 0.81^{a,b}$	68.17 ± 0.64^{b}

Means ± standard error carrying different capital letters (A, B) within the same column and parameter are significantly differed ($p \leq 0.05$) (Effect of breed).
Means ± standard error carrying different superscript (a, b, c, and d) within the same row and parameter significantly differed ($p \leq 0.05$) (Effect of season).

Table 5. Effects of season and breed of sheep fertility, litter size and gender ration in two sheep breeds

Parameter	Breed	Autumn	Winter	Spring	Summer
Pregnancy rate	Assaf	83.33 (65/78)*	46.67 (14/30)	53.33 (16/30)	40.00 (12/30)
	Awassi	71.67 (43/60)	53.33 (16/30)	60.00 (18/30)	46.67 (14/30)
Fecundity	Assaf	1.44 (112/78)**	0.57 (17/30)	0.6 (18/30)	0.43 (13/30)
	Awassi	0.78 (47/60)	0.57 (17/30)	0.6 (18/30)	0.47 (14/30)
Litter size	Assaf	1.72 (112/65)**	1.21 (17/14)	1.13 (18/16)	1.08 (13/12)
	Awassi	1.09 (47/43)	1.06 (17/16)	1.00 (18/18)	1.00 (14/14)
Male to female ratio	Assaf	60:52	7:10	10:8	7:6
	Awassi	20:27	8:9	8:10	6:8

*p value = 0.09 (Chi square test) between the two breeds.
**p value = 0.00001 (Chi square test normalized to twin 2 lambs born from 1 ewe) between the two breeds.

DISCUSSION

Seasonal variations in semen characteristics were observed. Semen volume, sperm concentration, percentage of live sperm, abnormal sperms and sperm motility varied within breeds with season change. Semen volume and SCC were significantly higher ($p \leq 0.05$) in autumn in all breeds. Changes in day length influence testicular activity by modifying the release of GnRH and thus the gonadotropins. In seasonal breeders, the volume of the ejaculate is high in the breeding season and decreases in the non-breeding Season. The present findings agreed with the results that previously reported for seasonal variations in semen volume and sperm concentration of rams and bucks (Zarazaga et al., 2009; Suhair and Abdalla, 2010). In our study, some variations were detected in semen motility among seasons. These findings were in agreement with the results of (Ibrahim, 1997) and (Fowler, 1965) who reported seasonal variations of progressive sperm motility in local crossbred and Merino rams. This response can be caused by different Factors, including availability of essential nutrients in various seasons (Onstad, 1967; Amir and Volcani, 2009) and seasonal variations of hormonal profile (Dorostgoal, 2006; Hamidi et al., 2010). In our study, sperm abnormalities were significantly highest ($p \leq 0.05$) in summer and lowest in autumn in all breeds. The high summer temperature had also its adverse effect on sperm livability. These results agree with the results of (Gündoğan, 2007) who reported a moderate decrease of abnormal sperms in breeding season (autumn) as Compared to the non-breeding season in Daglic fat-tailed rams. Galil and Galil (2009) and Suhair and Abdalla (2010) reported seasonal change in percentage of live and abnormal sperms in desert rams. Decreased live sperm percentage and increased abnormal sperm percentage in non-breeding season could be related to the decrease in number of seminiferous tubules and increase in degenerative processes (Suhair and Abdalla, 2010). Our results showed significant seasonal variation in testosterone level in all breeds. These results are in agreement with the results of (Abecia et al., 2012) who recorded that the reproductive seasonality is a phenomenon influenced mainly by annual variations in the photoperiod such that reproductive and non-reproductive seasons are well defined among seasonal species. The current results are also in agreement with the results of (Dorostgoal, 2006; Hamidi et al., 2010) who recorded seasonal variations of hormonal profile in different breeds of sheep among different seasons. Nonetheless, the magnitude of these seasonal effects should not prevent the animals from breeding.

In conclusion, the results showed the superiority of Assaf over Awassi breed in the given seasonal conditions and offer a good model of breeding with increased twinning rates specially in autumn season.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

AUTHOR CONTRIBUTIONS

HA Zaher: Conceptualization, Methodology, Visualization, Supervision.

SA Alawaash: Project administration, Funding acquisition, Supervision, Resources.

AA Swelum: Methodology, Data analysis, Visualization, Writing - review & editing.

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