SEASONAL AND ALTITUDINAL EFFECTS ON THERMOREGULATION AND SEMEN QUALITY VARIABLES OF AWASSI RAMS

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ABSTRACT

Experiments were carried out during moderate and hot seasons on 10 Awassi adult rams situated at different locations: the central coast (~150 m) and mountain region (~1150 m) to determine seasonal and altitudinal effects on thermoregulation and semen quality. All rams received the same diet (14.2 % crude protein) and were confined under similar conditions. Climatological data, indicators of adaptation (respiration and pulse rates, rectal temperature), body weight, scrotal dilatation and scrotal circumference as well as semen characteristics (volume, sperm concentration, motility and abnormality) were registered on weekly basis. Results showed that, during the moderate season at both altitudes, the respiration rate was significantly lower (55.7 and 34.7 vs 71.4 and 49.0 breath/ min, respectively) with the lowest recorded value (34.4 ± 15.2) at the 1150 m altitude, while the pulse rate was significantly higher (100.6 and 95.1 vs 82.2 and 86.5, beats/ min, respectively) as compared to the hot season. Body temperature in both seasons was also significantly lower (39.3 and 39.0 ºC, respectively) at the 150 m altitude in comparison with the results obtained at 1150m (39.5 and 39.1, respectively). However, body temperature did not differ significantly among seasons at the 1150 m altitude. The recorded values for scrotal dilatation were slightly higher at the 150 m altitude for both seasons with largest dilatation scores (16.2 cm) occurring at the hot season. Semen volume and motility increased significantly during the hot season at both altitudes, whereas sperm concentration was significantly higher during both seasons at the high altitude with no significant changes in semen abnormality. It is concluded that hot season at high altitudes did not adversely affect the animal physiological parameters as well as its semen volume and quality.

Keywords: Awassi ram, semen, thermoregulation, season, altitude

INTRODUCTION

Awassi sheep predominate in the Middle East and are well adapted to prevailing conditions. They travel through local deserts in search of water and feed. In Lebanon, the local Awassi breed, which is known as "Mountain sheep" with a population of about 250,000 heads (P.N.U.E., 1996), was naturally selected to tolerate the highly unfavorable environmental conditions. Bedouins that lead a nomadic way of life raise most of the sheep flocks in Lebanon. They travel to Syria (Northern Palmyra) during the moderate seasons and come back to Lebanon (Bekaa and anti-Lebanon slopes) in hot seasons to graze on the available pastures. They move also from the narrow 220 km long on the coastal regions to high altitudes and slopes located parallel to the 42 km wide Bekaa region during spring and summer seasons.

Raising animals at high altitudes leads to injuries in the testicles, weakness in spermatogenesis, destruction of germinal epithelium and testicular atrophy (Hafez, 1968; MacArthur *et al*., 1979). The reasons for such defects were attributed to variations in ambient temperature, atmospheric pressure and relative humidity, as well as nutrition. All these environmental and external variations affect the semen quality at high altitudes of 3000 m, leading to a decrease in semen motility and concentration, and elevated levels of pH and abnormal spermatozoa (Monge *et al.,* 1945; Clegg, 1968).

In previous studies, Eyal (1963), Juma *et al.,* (1971), Mabrouk *et al.,* (1977), Abi Saab and Sleiman (1986) and Sleiman and Abi Saab (1995) examined a number of factors affecting some of the physiological indicators of Awassi rams and their response to different environments.

Not many studies have been undertaken in the Middle East concerning acclimatization of Awassi sheep at different altitudes. The present study was conducted at an altitude of 1150 m in a mountainous area characterized by acute slopes and distinct variations in atmospheric temperature and relative humidity. The effect of altitude (1150 m) on some physiological indicators of adaptation in sheep (respiration, pulse rate, and body temperature), and on thermoregulation of animal's body (scrotal circumference and dilatation) and on quality of semen (volume, concentration, motility and abnormality), during moderate and hot seasons of the year was studied.

MATERIALS AND METHODS

Animals

The trial involved a total of 10 Awassi adult rams, eighteen months of age with a mean body weight of 49.9±0.7 kg. Rams were randomly divided into 2 groups of 5 each and transferred to 2 locations situated at different altitudes of Mount-Lebanon. The first location was in *Hboub ~150 m* on the central coast, and the other in *Ehmej ~ 1150 m* in the mountain region. At the experimental sites, all rams were submitted to a preparatory period of 3 weeks and received the same diet under similar confined conditions. All rams were kept during the day unsheltered on an open yard and housed during the night. Body weight was recorded on a weekly basis.

Diets and hygiene

A ration mixture formulated to meet the requirements suggested by the NRC (1984) provided about 14.2 % crude protein (CP) to maintain their recommended weight. The mixture consisted of barley (30%), corn (40%), soybean (10%), wheat bran (17%) and molasses (1%), in addition to adequate amounts of minerals and vitamins (2%) as recommended by Arab and Middle East Tables of Feed Composition (1979). During the preparatory period, each ram was provided with 500 g of the mixture daily and liberal access to a cereal-legume mixture of straw. This quantity was gradually increased for 3 weeks, to attain a constant amount of 850 g of mixture and 1 kg of straw/head/day, by the starting point of the experiment. Animals were allowed to graze on the rangeland pasture providing mainly what was available of grasses, legumes and shrub foliage for 2 h/day and then were housed in the barn. All animals had free access to water. Hygiene conditions were identical and optimal for both groups. In addition, a vaccination program was applied against all diseases commonly present in the area such as pox, rinderpest, foot and mouth disease, enterotoxemia and anthrax. A prophylaxis of dipping and drenching was done to inhibit internal and external parasites.

Climatological data

The experimental period of 8 months was divided into 2 thermic seasons. The moderate season included February, March, April, and May and hot season included June, July, August, and September. The measurement values of temperature (T) and relative humidity (RH) were collected in meteorological stations at both sites, by standard meteorological procedures.

Physiological indicators of adaptation

The physiological indicators were the measurements of respiration and pulse rate and rectal temperature. Data of the first two indicators were collected using the Perless type stethoscope DW 7940 Silver*,* on the left side of the animal, in a calm position for one minute. Body temperature was taken in the barn using a clinical thermometer inserted into the rectum for 3 minutes.

Scrotal circumference and dilatation

A measuring tape was used to register the data of these two indicators. Scrotal circumference (SC) was taken in the morning at the middle part of the testicle. (Foote, 1984). Scrotal dilatation (SD) was measured and calculated by the following formula: $SD = L - l$, where 'L' is the distance (cm) between the point of attachment of vertical testicular cordons with the abdomen, and a point on the horizontal ground level beneath the animal, while 'l' is the distance between the scrotal base and the same point on the horizontal ground level.

Data of the climatological, physiological indicators of adaptation and scrotal dilatation were collected at different times in a day (early in the morning at 6 a.m., at mid day, and late afternoon at 6 p.m.), at weekly basis.

Semen evaluation

Semen was collected on weekly basis by means of an electro-ejaculator. Semen volume was measured by means of a graduated tube. Semen motility was checked from zero to 100 %. The concentration of semen was determined under a microscope using a haemocytometer. Semen abnormality was checked according to Evans and Maxwell (1987).

Statistical analysis

One-way analysis of variance (ANOVA) was conducted using “Sigmastat software” to evaluate differences between treatment means. Probability levels (P) equal to or less than 0.05 were considered significant in all tables, while correlation between means was consistent at (*) $P<0.05$, (**) $P<0.01$ and (***) $P<0.001$. Results in tables are illustrated as mean (X) ± standard deviation (SD).

RESULTS AND DISCUSSION

Climatological conditions

The weekly variations of T and RH in the 2 locations throughout the experiment are illustrated in Figures 1 and 2. During moderate season, the average air temperature reached in the late afternoon its minimum value of 13.1 in February at coastal area and 6.7 °C at mountainous areas with average RH of about 65 %. The maximum T was 23.0 and 17.4 °C in May for the 2 locations, respectively with an average RH of 61 %. The highest T of 27.8 and 23.3 °C was recorded in coastal and mountainous areas, respectively. The lowest T was 23 and 17.2 °C in coastal and mountainous areas, respectively, while the average RH during this season was 59 %.

Body weight

Figure 3 illustrates the weekly variations of the rams’ body weight in both seasons. At the end of the moderate season, body weight was similar at both altitudes (54.8 at 150 m and 54.2 kg at 1150 m.), whereas at the end of the hot season, the body weight was slightly lower at the high altitude (57.9 *vs* 61.5 kg). It is important to mention that feeding at the two locations and seasons was not altered.

Physiological indicators of adaptation

Table 1 illustrates the different physiological indicators of adaptation to the prevailing environmental conditions in terms of respiration and pulse rates and body temperature.

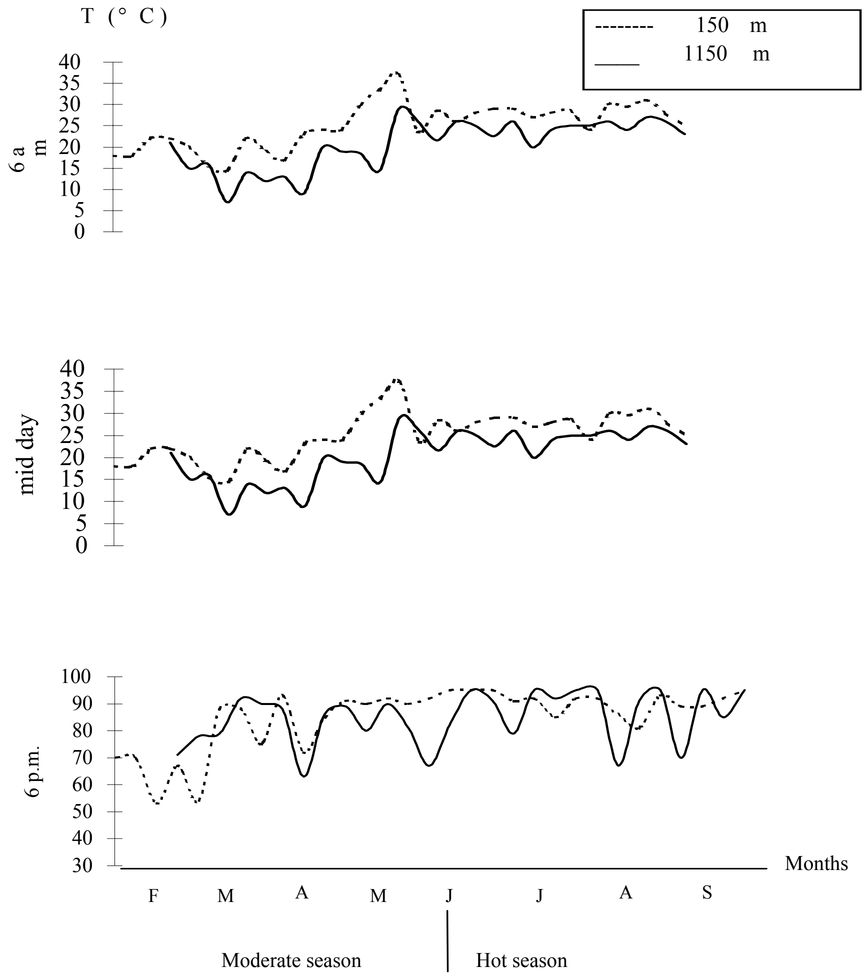


Figure 1. Weekly variations of ambient temperature of the experimental locations.

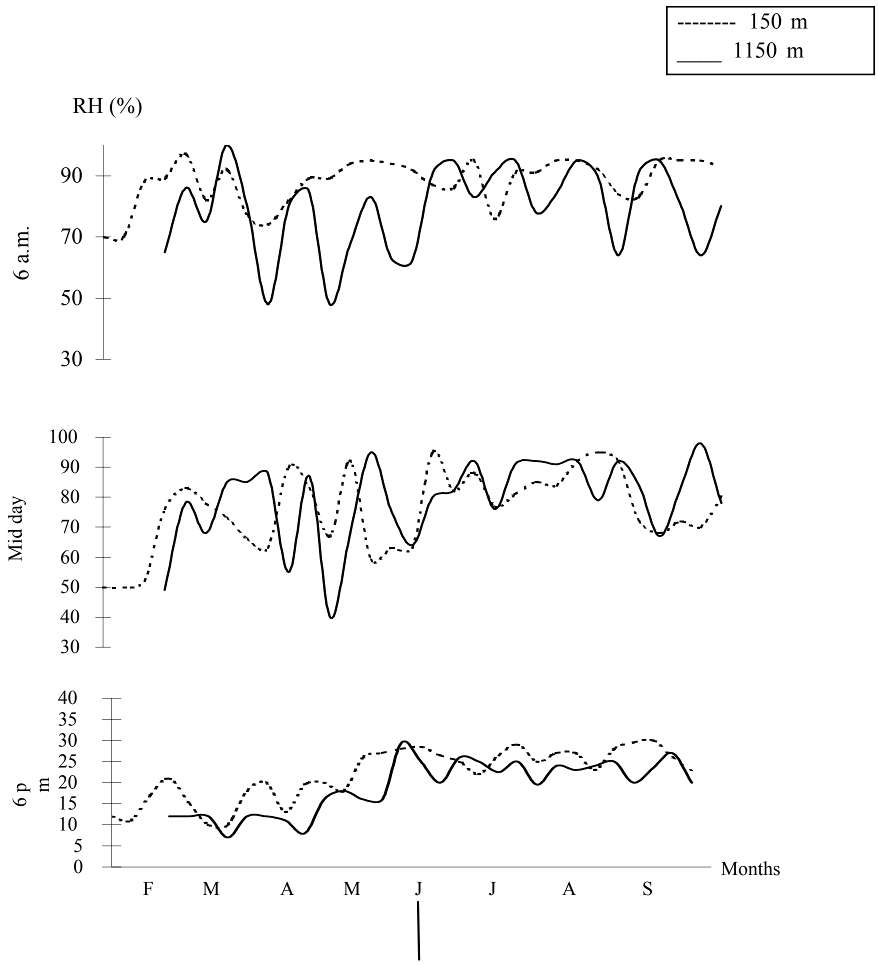


Figure 2. Weekly variations of relative humidity of the experimental locations.

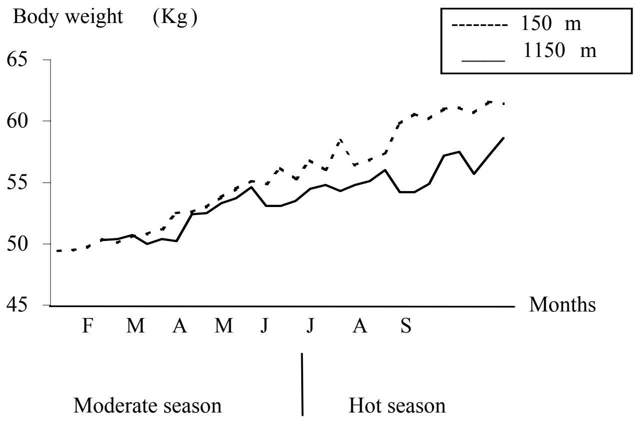


Figure 3. Seasonal and altitudinal effects on live body weight.

TABLE 1
Seasonal and Altitudinal Effects on Some Physiological Indicators of Adaptation

	150 m		**1150 m**	
	Moderate	**Hot**	**Moderate**	**Hot**
Respiration rate (breath/min)				
6 a.m.	34.2±10.3^{a}	47.3±9.9^{a}	29.8±11.5^{a}	33.4±9.9^{a}
mid day	72.8±37.9^{ab}	91.7±17.4^{a}	41.2±20.1^{c}	60.6±24.3^{bc}
6 p.m.	60.2±24.1^{a}	75.0±12.0^{a}	33.2±11.0^{b}	55.1±23.9^{ab}
daily average	55.7±30.7^{a}	71.4±22.7^{b}	34.7±15.2^{c}	49.0±23.1^{a}
Pulse rate (beats/min)				
6 a.m.	86.0±10.2^{ab}	74.3±9.2^{a}	95.3±10.4^{b}	81.1±10.1^{a}
mid day	108.9±11.6^{a}	91.1±10.0^{b}	98.7±12.2^{ab}	90.8±12.8^{b}
6 p.m.	106.9±13.5^{a}	82.9±12.2^{b}	91.2±13.1^{b}	87.4±9.0^{b}
daily average	100.6±15.6^{a}	82.8±12.4^{b}	95.1±12.1^{a}	86.5±11.3^{a}
Body temperature (˚C)				
6 a.m.	39.0±0.5^{a}	38.8±0.2^{a}	39.4±0.3^{b}	39.0±0.3^{a}
mid day	39.4±0.3^{ab}	39.2±0.3^{a}	39.5±0.2^{b}	39.1±0.3^{a}
6 p.m.	39.8±0.3^{ab}	39.2±0.2^{ab}	39.5±0.3^{a}	39.1±0.2^{b}
daily average	39.3±0.5^{a}	39.0±0.3^{b}	39.5±0.3^{a}	39.1±0.3^{a}

abc Means within the same row with no common superscript differ significantly (p<0.05).

Respiration rate

Respiration rate was positively correlated (r=0.6)* with ambient temperature at an altitude of 150 m, and negatively correlated with RH (r = -0.7)* at 1150 m. Thus, whatever the altitudes and seasons were, respiration rate increased proportionally with the elevation of ambient temperatures. The increase in respiration rate at 1150 m altitude was due to higher ambient temperatures at this elevation. Note that ambient temperature at mid day at both locations caused panting in animals.

Pulse rate

At the beginning of the experiment, an increase in the pulse rate was noticed due to the unusual presence of nearby humans. A high pulse rate was observed at mid day which coincides with the results obtained by Blood *et al.* (1970) and MacArthur *et al.* (1979;1982). The higher pulse rate values observed during the moderate seasons at the different locations could be related to selfheating during cold times or selfcooling during hot times.

Body temperature

The mean values of body temperature showed that during the moderate season at 150 m were significantly lower (39.3 ± 0.4) than body temperature obtained (39.5 ± 0.3 °C) at 1150 m and negatively correlated (r=-0.6)** with ambient temperature and positively correlated (r=0.6)* with pulse rate. Same results were observed at 1150 m, where body temperature was positively correlated (r=0.8)*** with pulse rate too.

Body temperature was lower in the morning, compared to mid day and late afternoon, and this was in accordance with the results obtained by Eyal (1963). As it was expected, results of respiration and pulse rates at high altitudes differ slightly than those obtained at coastal area.

Results of respiration and pulse rates and body temperature obtained were in agreement with Sleiman and Abi Saab (1995).

Scrotal circumference and dilatation

The scrotal circumference and dilatation values are reported in Figures 4 and 5. Scrotal circumference at 1150 m showed a positive correlation with T (r=0.7)*** and RH (r=0.5)*. This parameter was stable at 150 m during the moderate season but fluctuated during the hot season due to the increased ambient temperature resulted from the so-called " Khamsin wind" in the region. During the second half of the hot season, the scrotal circumference showed a progressive increase due to shearing. Scrotal dilatation in both seasons was higher in mid day and at 6 p. m. than at 6 a.m. at both altitudes. During the moderate season, at both altitudes, the mean values of scrotal dilatation were significantly lower than that of the hot season. This indicator increased with the elevation of ambient temperature at the 2 locations, in agreement with Hafez (1968) and Khalil *et al*., (1990), who reported that the scrotum possesses a thermoregulative function in adhering the testes to the surface of the abdomen when the ambient temperature is lower than 6 °C, and descending them down as far as possible from the abdomen when the ambient temperature becomes higher than 24 °C.

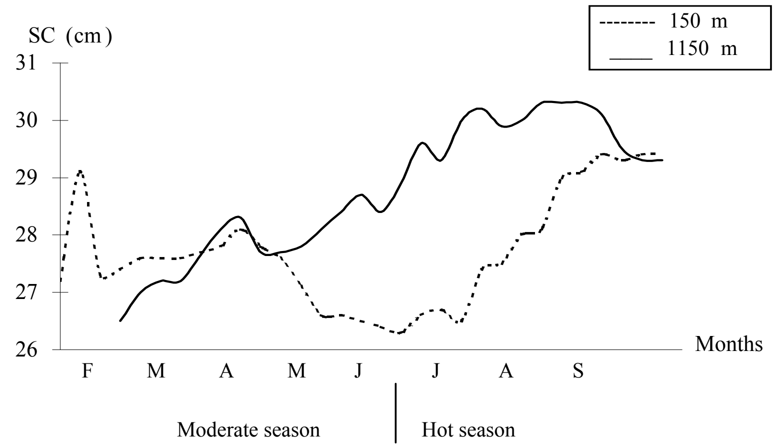


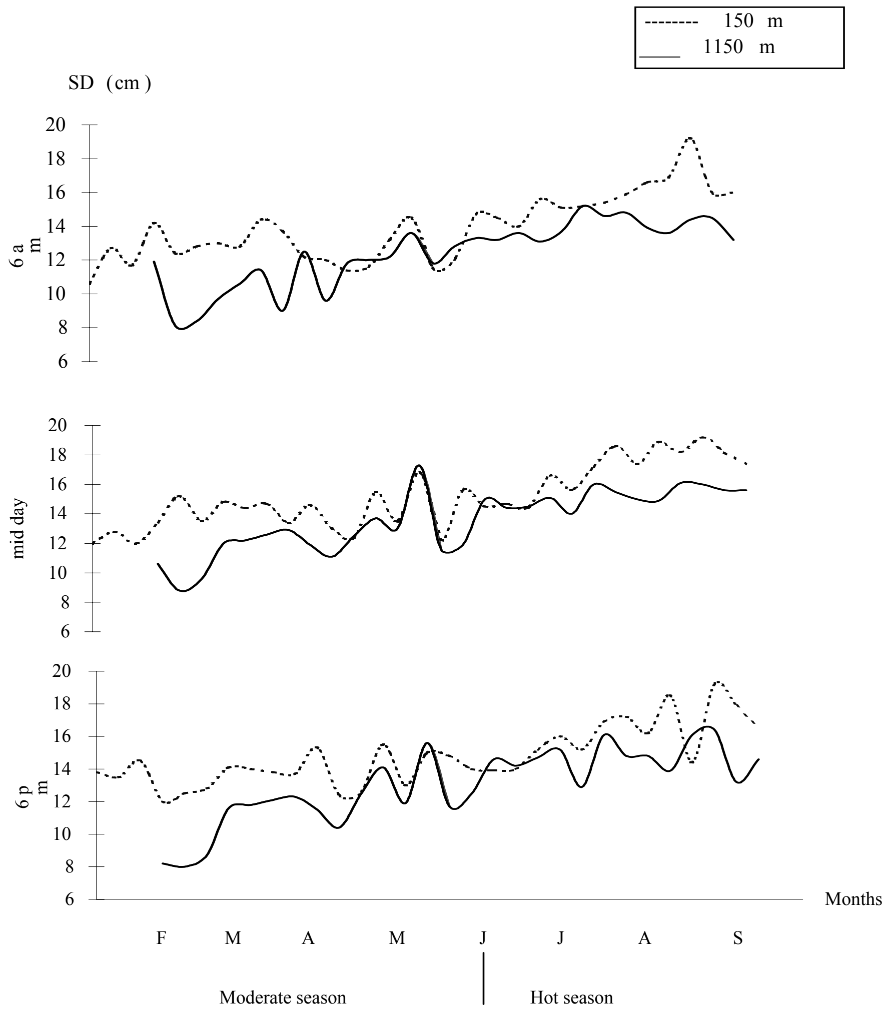
Figure 4. Seasonal and altitudinal effects on scrotal circumference.

During the hot season at 150 m and 1150 m, scrotal dilatation showed a positive correlation (r=0.6)** with scrotal circumference. In general, scrotal dilatation varied in relation to ambient temperature. The higher the temperature, the more the testicles dilate. Consequently, this dilatation is maximized during mid day at 150 m during the hot season.

Semen volume, motility, concentration and abnormality

Semen volume, sperm motility, concentration and abnormality are illustrated in Table 2. Semen volume at both altitudes had approximately the same value, and showed at 150 m a positive correlation (r=0.6)* with ambient temperature during the moderate season. During the hot season the maximal volume from August - October was in agreement with Wiggins *et al*. (1953) and Abi Saab and Sleiman (1986) and had a positive correlation (r = 0.5)* with testes circumference. The increase in semen volume during the hot season was due to the fact that sexual activity of rams reached its maximum at the end of summer, which coincided with the breeding season (Abi Saab and Hamadeh, 1984).

During moderate season at the 1150 m altitude, motility was positively correlated with volume of semen (r=0.8)*** and scrotal circumference (r=0.6)* and that the greatest increase was at the beginning of the breeding season. The average value of motility during the hot season at both altitudes was 80 %, with a peak of motility in mid-summer in agreement with the findings of Abi Saab and Hamadeh (1984) and Abi Saab and Sleiman (1986).



150 m
1150 m
SD (cm)
6 a m
mid day
6 p m
20
18
16
14
12
10
8
6
Months
F
M
A
M
J
J
A
S
Moderate season
Hot season

Semen concentration during both seasons was lower at 150 m in comparison with 1150 m, in agreement with Hiroe and Tomizuka (1966) and Abi Saab and Sleiman (1986).

No significant differences in sperm abnormalities were observed between seasons and between altitudes.

TABLE 2
Seasonal and Altitudinal Effects on Semen Quality

Semen characteristics	150 m		1150 m	
	Moderate	**Hot**	**Moderate**	**Hot**
Volume (ml)	0.60±0.2[a]	1.0±0.2[b]	0.7±0.2[a]	1.0±0.2[b]
Motility (%)	70.8±7.6[a]	84.4±4.7[b]	71.7±7.2[a]	85.0±4.2[b]
Concentration (cells x 10^9/ml)	1.1±0.4[a]	1.1±0.4[a]	2.3±0.7[b]	2.1±0.4[b]
Abnormality (%)	12.9±1.6[a]	13.3±1.6[a]	13.7±1.8[a]	14.3±1.8[a]

[ab]*Means within the same row with no common superscript differ significantly (p<0.05).*

The indicators of adaptation of a group of 10 Awassi rams to both altitudes showed that respiration rate increased proportionally with the increase in ambient temperature with no direct influence of the altitude or the season. Pulse rate decreased as ambient temperature increased at both altitudes, where it was higher during the moderate in comparison with the hot seasons. Testicular dilatation had higher values during both seasons at 150 m due to the thermoregulatory function of the scrotum. The semen volume, and sperm motility were not affected by altitude. It is thus a good practice to perform a fertility test immediately after moving the rams to high altitude if early insemination is needed.

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