

Semen Physical Traits and Thyroid Activity of Barki Rams as Affected by Season and Feeding Non-Edible Date Palm at Siwa Oasis, Egypt

A.L.S. Hashem

Department of Animal Physiology, Animal and Poultry Production Division,
Desert Research Centre, Cairo, Egypt

Abstract: This study was designed to determine the effect of partial substitution of ground yellow corn (GYC) in concentrate feed mixture (CFM) with ground date palm (GDP) at 50% (wt/wt) level on body weight (BW), plasma T_3 , T_4 testosterone concentrations (TC) and some semen physical characteristics. The study was carried out at Siwa Research Station (Tegzerty Experimental Farm for Animal Production), which belongs to Desert Research Center, Cairo, Egypt. The study was carried over a 12-month period (four seasons): summer (June to August), autumn (September to November), winter (December to February) and spring (March to May). Twenty adult Barki sheep (12 month of age) with average body weight 45.03 ± 0.22 kg were allocated into two groups (10 in each) and were separated in two sheltered enclosures. The first group served as control group, while the other served as treated group. Semen was collected once monthly via artificial vagina and evaluated for ejaculate volume (EV), sperm concentration (SC), total sperm output per ejaculate (TSO), sperm mass motility (SMM), sperm progressive motility (SPM), live sperm percentage (LSP) and semen pH. Blood samples were also taken monthly throughout the study period. The concentration of thyroid hormones, triiodo thyronine (T_3) and thyroxin (T_4) in addition to testosterone hormone (TC) were determined. Body weight was un-affected significantly ($P > 0.05$) in treated rams than control where the rate of change recorded 5.55 and 5.79% for control and treated groups, respectively. Plasma testosterone, T_3 and T_4 concentrations were significantly ($P < 0.01$) different between seasons. The lowest concentrations were recorded in summer and autumn months than winter and spring months for T_3 and T_4 in both groups. Circulating testosterone hormone (TC) followed the opposite trend of T_3 and T_4 concentrations in both control and treated groups over the year. Treatment has significant ($P < 0.05$) effect on circulating T_3 and TC. Slight improvement of semen quality and quantity has been observed in treated rams compared with control group. In addition, the best semen quality and quantity has been generally noticed during autumn season in both groups. Results indicated that EV influenced negatively SC and positively the calculated TSO in both groups throughout the study. The present results indicated that autumn season displayed the best results in circulating testosterone and both quality and quantity of semen physical characteristics in both groups. Autumn months were the best season than the other seasons for breeding sheep. Semen quality and quantity of Barki rams were not affected by the high summer temperatures at Siwa Oasis.

Key words: Date palm • Rams • Seasonal variations • Semen traits • T_3 , T_4 • Testosterone

INTRODUCTION

Date waste contains carbohydrates and minerals and is a significant source of energy. Thus, it may be possible to use date waste as an energy source for ruminants. Date fruit can provide 2.67 Mcal/kg of digestible energy. In comparison, barley provides 3.06 Mcal/kg of digestible

energy. Because dates contain approximately 78.5% dry matter, 2.2% crude protein, 0.5% crude fat, 2.3% crude fiber, 72.9% carbohydrate and 1.9% ash, dates can supply 87% of the digestible energy provided by the same unit mass of traditional feed grain [1]. The amount of energy in the diet and the source of energy affect the animal's feed conversion efficiency [2]. Dates contain a high percentage

Corresponding Author: A.L.S. Hashem, Department of Animal Physiology, Animal and Poultry Production Division, Desert Research Centre, Cairo, Egypt.

of carbohydrate, fat comprising 14 types of fatty acids, 15 salts and minerals, protein with 23 different amino acids and proteins, six vitamins and a high percentage of dietary fiber [3]. Discarded dates are characterized by having high Total Digestible Nutrient (TDN) and being palatable for livestock [4]. Animal performance is closely related to the regeneration of metabolism and functioning of the endocrine system. A close relationship between thyrotropin-releasing hormone (THR), thyroid stimulating hormone (TSH), triiodothyronine (T_3), Thyroxine (T_4) and growth hormone (GH) had been found and this axis plays an important role in growth [5].

In sheep, sexual behavior and semen quality are the main factors that limit male reproduction efficiency along the year [6]. These factors could vary according to the breed [7], season of the year [8] and nutrition level [9]. Almeida *et al.* [10] reported that Corriedale rams expressed seasonal variation in their reproductive variables (scrotal circumference and semen quality). Perez *et al.* [11] found that the testis activity was highest in late summer/early autumn and lowest in winter. The reproductive ability of sheep is influenced by seasonal factors such as temperature, relative humidity and the number of sunny hours [12]. Also, Pourseif *et al.* [13] reported that the best semen in rams is produced during late summer to second month of autumn. Testosterone is the most important male reproductive hormone; it is related to reproductive behaviour, spermatogenesis and secondary sexual characteristics [14]. Ram blood testosterone levels vary according to breed, nutrition level, season and age [15, 16]. Thus, the present study was performed to evaluate the effect of partial substitution (50%, weight/weight) level of ground yellow corn (GYC) with ground date palm (GDP) in concentrate feed mixture (CFM) on live body weight, some semen physical characteristics, thyroid activity (T_3 and T_4) and testosterone concentrations of Barki rams over a 12-month period (4-seasons) at Siwa Oasis, Egypt.

MATERIALS AND METHODS

This study was performed at Siwa Research Station (Tegzerty Experimental Farm for Animal Production), which belongs to Desert Research Center (DRC), Cairo, Egypt, during the period of 12 months (4-seasons). Siwa Oasis is characterized by desert climate. Photoperiod in this Oasis varies from 13h 40 min of light at summer solstice (21 June) to 11h 20 min of light at winter solstice. Table 1 summarized the average monthly ambient

temperature (AT, °C) and relative humidity (RH, %) at 07:00 am and 13:00 pm throughout the study.

Animal Management and Experimental Design: Twenty adult (1-year aged) Barki Rams with average body weight (BW) of 45.03 ± 0.22 kg, were used. The animals were divided into two main groups (10 in each). Animals were separated in two sheltered enclosures and fed in group feeding system. The first group served as control group (C) and fed a basal diet consisting concentrate feed mixture (CFM), plus berseem hay (Alfalfa). The second group served as treated group (T) and fed partial replacement (50%) of ground yellow corn (GYC) with ground date palm (GDP) in concentrate feed mixture (CFM) plus berseem hay (Alfalfa). The nutritional requirements were adjusted according to Kearn [17]. Drinking water was offered *ad lib* twice daily. All animals of both groups were offered the CFM allowance in two parts at 09:00 a.m. and 04:00 p.m. daily. Composite feedstuffs samples were taken and stored for laboratory proximate analysis purpose, which were analyzed according to the methods of the A.O.A.C. [18]. Compositions of the experimental rations are shown in Table 2.

Experimental Treatment: In Siwa Oasis, one of the date palm (*Phoenix dactylifera* L.) varieties namely Azzawi date palm classified as unfit for human consumption or in the nutritional industries. It was used in feeding farm animals (sheep, goat, cattle and donkeys). Azzawi date was sun dried and given to the animals in the form of intact or crushed (with the seeds). In the present study, Azzawi date was ground and used in partial replacement (50% wt/wt) of GYC in CFM to be fed for treated group. Monthly, prepared rations (for control and treated groups) were kept in containers made of jute-sack (50kg capacity) to use it.

Diets Chemical Composition: Data in Table 3 showed mean chemical analysis of Azzawi date ingredient (CFM) and Alfalfa hay as roughage for control and treated groups. It's worthy to note that, crude protein was higher in diet combination given to control group (16.14%) than treated group (13.66%). On the other hand crude fibers in diet combination given to treated group (8.91%) was higher than control group (7.92%).

Body Weight: Body weight was recorded monthly to the nearest 100 grams.

Table 1: Averages of ambient temperature (AT, °C) and relative humidity (RH, %) throughout the study

Season	Month	AT, °C		RH, %	
		07:00 am	13:00 pm	07:00 am	13:00 pm
Summer	June	29.8±0.64	35.5±0.77	71.3±1.59	55.7±1.33
	July	30.4±0.75	38.2±0.79	67.7±1.71	54.8±1.41
	August	32.5±0.77	40.5±0.59	65.8±1.69	51.4±1.39
Autumn	September	29.3±0.59	37.2±0.61	69.9±1.71	53.6±1.29
	October	26.5±0.61	31.4±0.66	72.9±1.66	55.9±1.32
	November	21.7±0.63	29.6±0.71	74.5±2.11	59.4±1.39
Winter	December	17.8±0.59	24.3±0.61	78.2±1.61	56.7±1.49
	January	16.5±0.66	21.5±0.69	79.4±1.59	58.3±1.38
	February	16.9±0.59	25.9±0.67	78.5±1.66	55.7±1.37
Spring	March	18.9±0.66	28.3±0.64	77.4±1.77	57.6±1.33
	April	20.7±0.70	31.4±0.79	75.4±2.31	56.3±1.37
	May	23.5±0.67	34.5±0.81	74.5±2.12	53.4±1.41

Table 2: The composition of experimental rations for control and treated groups of Barki rams throughout the study

Ingredients (%)	Control	Treated
Ground yellow corn	59.6	29.8
Ground dates	0	29.8
Cotton seed meal	21.5	21.5
Wheat bran	15.7	15.7
Limestone	1.3	1.3
Sodium chloride	1.3	1.3
Mineral mixture	0.6	0.6

Table 3: Chemical analysis (%) of experimental rations

Ingredient	C	T	Hay	Azzawi date
Dry matter (DM)	93.21	92.84	88.8	92.81
Organic matter (OM)	92.41	91.09	--	90.24
Crude protein (CP)	16.14	13.66	17.5	7.19
Ether extract (EE)	5.26	3.78	1.38	6.65
Crude fiber (CF)	7.92	8.91	28.2	4.56
Ash	7.59	8.91	11.61	2.67

C = control group T = treated group

Semen Collection and Evaluation: Semen was collected monthly from each ram; the short form artificial vagina (40-42°C) was used for semen collection. Semen quality parameters (Ejaculate volume (EV), PH, sperm concentration (SC), sperm mass motility (SMM) and live sperm percentage (LSP). were evaluated according to Evans and Maxwell [19]. In addition, total sperm concentration was calculated.

Blood Collection and Hormonal Assay: Monthly, a jugular blood sample was collected from each ram in 10 ml vacutainer heparinized tubes and immediately centrifuged at 3500 x g for 20 min. The harvested plasma was aspirated in a clean labeled penicillin glass and then stored at -20°C until hormone was assayed. The concentration of plasma

testosterone (ngml⁻¹) was determined in all samples according to the method of Kicklighter and Norman [20]. Testosterone levels in sheep plasma were measured in a simple solid phase competitive ELISA by commercial kits (Human, Wiesbaden, Germany). The concentrations of triiodothyronine (T₃, ngml⁻¹) and thyroxine (T₄, µgdl⁻¹) in plasma were determined according to Barker and Silverton [21] by using commercial kits supplied by Monobind Inc.

Statistical Analysis: Data were expressed as means (X±S.E.) and analyzed using the Statistical Analysis System [22]. A mixed model analysis of variance was used to determine the effect of treatment, season and their interactions on BW, some semen physical traits, plasma T₃, T₄ and testosterone concentrations were considered the main factors. Differences among means were tested according to Duncan's Multiple Range Test [23].

RESULTS AND DISCUSSION

Body Weight Changes: Averages of BW for control and treated groups are presented in Table 4 and graphically in Fig. 1. At the start of study, the average body weight was 45.0±0.07 and 44.9±0.07 kg and reached similar values (47.5±0.07 and 47.5±0.07 kg) at the end of study for control and treated groups, respectively. Accordingly, minor increase in BW was observed with rate of change recorded 5.50 and 5.80% for control and treated groups, respectively. Statistical analysis indicated that there was non-significant (P>0.05) effect of treatment on BW in both groups. Previous studies reported that, the inclusion of discarded dates in the fattening ration of lambs [24, 25] and young camels [26] did not negatively affect animal health or productivity. On the contrary, Abdel-Fattah *et al.* [27] found that partial substitution of ground yellow corn in concentrate feed mixture with ground date palm at 50% weight by weight decreased (P<0.01) live body weight than control group of growing Barki lambs.

Table 4: Averages ±SE of body weight (BW, kg) of Barki rams fed GDP in CFM during different seasons

Season	C	T	Overall
Summer	45.0±0.07	44.9±0.07	44.98±0.047 ^d
Autumn	45.5±0.07	45.5±0.07	45.50±0.047 ^c
Winter	46.6±0.07	46.9±0.07	46.752±0.047 ^b
Spring	47.5±0.07	47.5±0.07	47.53±0.047 ^a
Overall mean	46.17±0.030	46.20±0.330	--

C = control group, T = treated group, GDP = ground date palm, CFM = concentrate feed mixture

a,b,c,d values marked with different letters in row are significantly different (a=P<0.05)

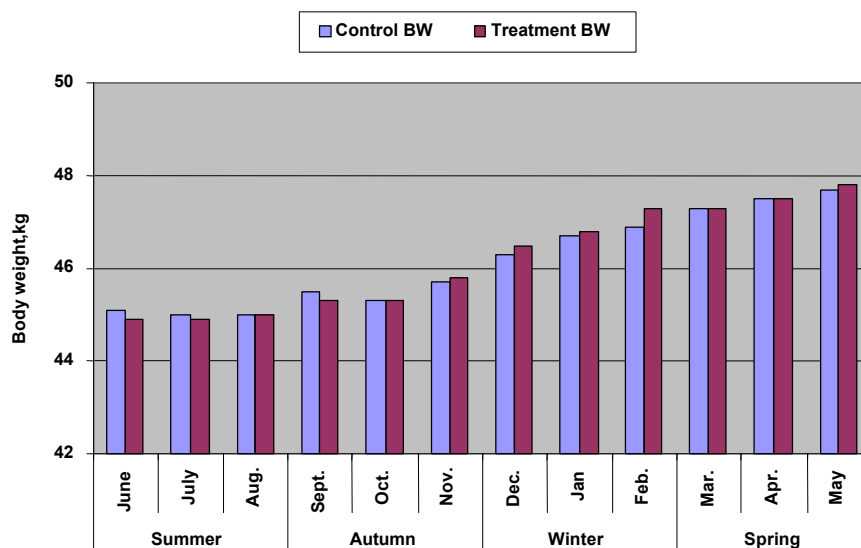
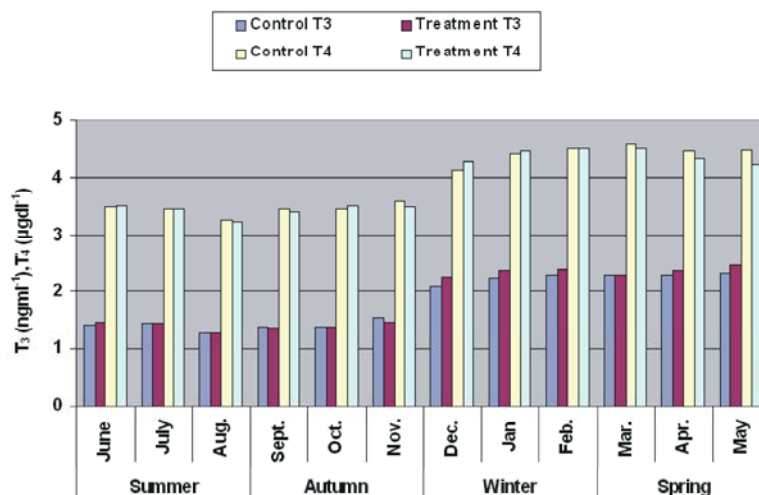


Fig. 1: Monthly and seasonal variations in body weight for control and treated rams at Siwa Oasis

Fig. 2: Monthly and seasonal variations in circulating T₃ and T₄ concentrations for control and treated rams at Siwa Oasis

Thyroid Activity and Plasma Testosterone: Among the important factors that have great impacts on metabolism and growth are thyroid hormones. Regardless the effect of season, the results indicated that, the overall mean of plasma T₃ and T₄ concentrations were nearly similar for control (1.82 ± 0.012 and 3.94 ± 0.015) and treated (1.90 ± 0.012 ngml⁻¹ and 3.91 ± 0.015 μgdl⁻¹) groups in each season, while the overall mean of plasma TC was (4.64 ± 0.032 ngml⁻¹ and 4.79 ± 0.032 ngml⁻¹), respectively, (Table 5). The determined values of circulatory T₃ and T₄ in the present study were within the range of published values for mammals [28, 29]. Statistical analysis showed that treatment had significant ($P < 0.05$) effect on plasma T₃ and testosterone concentrations, being higher in the treated groups. Regarding the effect of season, obvious differences were observed in circulating T₃ and T₄

concentrations in both control and treated groups where summer and autumn recorded the lowest ($P < 0.05$) values (Fig. 2) compared with winter and spring seasons, this reduction could be attributed to the environmental conditions (Table 1). Several investigators confirmed that the correlation between thyroid hormones and ambient temperature was negative [30-33]. Also, Marai *et al.* [34] confirmed that T₃ concentration in blood plasma was significantly lower ($P < 0.01$) in summer than in winter season in Ossimi x Suffolk crossbred sheep. The studies of Guerrini and Bartchinger [35] clarified that the decrease in T₃ level was correlated with the increase in rectal temperature, under hot climate conditions.

Previous studies reported that blood thyroid hormone concentrations were high in spring (increasing day length) and low in autumn (decreasing day length),

Table 5: Hormonal profile of plasma triiodothyroxine (T₃, ngml⁻¹), thyroxine (T₄, µgdl⁻¹) and testosterone (TC, ngml⁻¹) of Barki rams fed GDP in CFM during different seasons

Hormone	Group	Summer	Autumn	Winter	Spring	Overall mean
T ₃ (ngml ⁻¹)	C	1.38±0.03	1.44±0.03	2.21±0.03	2.32±0.03	1.82±0.012 ^B
	T	1.40±0.03	1.44±0.03	2.33±0.03	2.39±0.03	1.90±0.012 ^A
	Overall mean season	1.39±0.046 ^c	1.44±0.018 ^c	2.27±0.046 ^b	2.36±0.046 ^a	--
T ₄ (µgdl ⁻¹)	C	3.40±0.03	3.49±0.03	4.5±0.03	4.51±0.03	3.94±0.015
	T	3.39±0.03	3.47±0.03	4.43±0.03	4.35±0.03	3.91±0.015
	Overall mean season	3.40±0.021 ^c	3.48±0.021 ^b	3.39±0.021 ^a	4.43±0.021 ^a	--
TC (ngml ⁻¹)	C	5.50±0.03	6.40±0.03	3.40±0.03	3.30±0.03	4.64±0.032 ^B
	T	5.54±0.03	6.63±0.03	3.50±0.03	3.51±0.03	4.79±0.032 ^A
	Overall mean season	5.52±0.046 ^b	6.51±0.046 ^a	3.44±0.046 ^c	3.41±0.046 ^c	--

C = control group, T = treated group, T₃ = triiodothyroxine (T₃, ngml⁻¹), T₄ = thyroxine (T₄, µgdl⁻¹)

and TC = testosterone (ngml⁻¹), ^{a,b,c} values marked with different letters in row are significantly different (^a=P<0.05)

^{A,B} values marked with different letters in column are significantly different (^A=P<0.05)

which was not fully explained by the changes in environmental temperature [36-40]. Tajagookeh *et al.* [41] reported that the highest values of plasma T₃ and T₄ concentrations in rams were associated with the lowest values for ambient temperature, plasma testosterone concentration, testis volume and other semen parameters.

Corresponding values during spring season were (2.32±0.03 ngml⁻¹ and 4.51±0.03 µgdl⁻¹ vs. 2.39±0.03 ngml⁻¹ and 4.35±0.03 µgdl⁻¹) for control and treated groups, respectively. In agreement, Tajagookeh *et al.* [41] found that plasma T₃ and T₄ concentrations was significantly higher in winter and spring months than in summer and autumn months in Afshari, Shall and Zandi breeds of rams. It could be revealed that circulating T₃ and T₄ concentrations followed the same trend of body weight in both control and treated groups among all seasons of the year. From these results, there was a positive correlation between thyroid hormones (T₃ and T₄) and both season of the year and body weight. Similar results were reported by Mousa and Al-Saiady [28] who found that, there was a positive correlation between thyroid hormones levels in serum and body weight during the growing period of Somali camels fed different levels of commercial feeds. On the other hand, Todini [42] observed that marked seasonal variations in plasma thyroid hormone concentrations were associated with semen quality and quantity changes throughout the year.

Results in Table 5 and Fig. 2 indicated that winter and spring seasons showed the highest (P<0.05) values in both control and treated groups. The values of T₃ and T₄ for control and treated groups were (1.82±0.012 and 3.94±0.015 vs. 1.90±0.01 and 3.91±0.015) during winter season. Regarding the effect of treatment, results in Table 5 and Figs. 2 and 3 stated that rams fed GDP in concentrate feed mixture has significant effect (P<0.05) on both circulating T₃ and TC by about 4.39% and 3.23% for T₃ and TC, respectively compared with control rams.

Time course changes in plasma TC, T₃ and T₄ concentrations of treated group are shown in Figs. 2 and 3 and indicated that T₃ and T₄ concentrations peaked on February month while TC concentration peaked on September month. Previous study performed by Abdel-Fattah *et al.* [27] on Barki lambs fed ground date palm at Siwa Oasis and found that, there was a positive correlation between thyroid hormones (T₃ and T₄) and both the age of animal and body weight gain (P<0.01). Similar results reported by Mousa and Al-Saiady [28], who found that there was a positive correlation between thyroid hormones levels in serum and body weight during the growing period of Somali camels fed different levels of commercial feeds.

Gündoğan [43] reported that serum testosterone levels were to be higher during autumn months in Daglic and Chios rams and Mandiki *et al.* [44] in Texel, Suffolk and Ile-de-France rams. Also, Sarlós *et al.* [45] reported that the lowest blood plasma testosterone level (2.31±0.14 ngml⁻¹) was measured in winter and the highest in autumn (17.81±0.7 ngml⁻¹). Another study performed by Delgadillo and Chemineau [46] reported that plasma TC is related to season of the year.

Our results showed that monthly variations (P<0.05) were observed in both control and treated rams, where the lowest values of plasma TC were recorded in August month. It could be attributed to the maximum ambient temperature in this month (40.5±0.59). The highest values were recorded in November month (Fig. 3). This observation was similar to the results obtained on Rembi rams by Benia *et al.* [47]. The pronounced increase in circulating TC during autumn was also reported in the studies done by Kaya *et al.* [48] and Keskin and Kececi [49]. These researchers suggested that stimulation of the pituitary gland in the ram is more likely to begin in autumn during low ambient temperatures and reduced length of day.

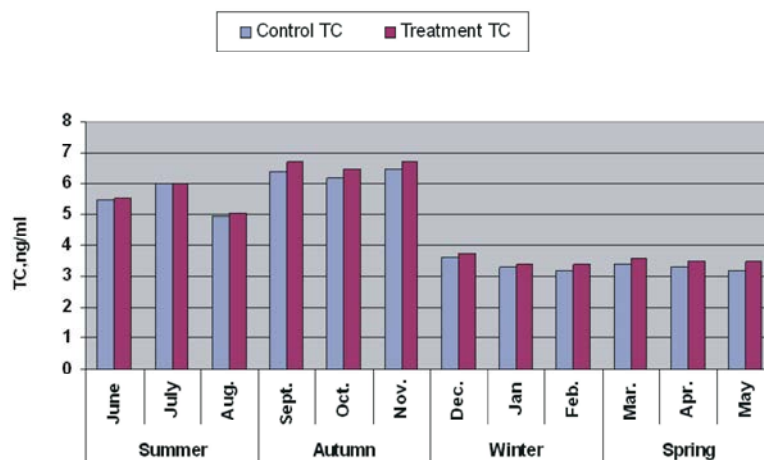


Fig. 3: Monthly and seasonal variations in circulating testosterone concentration (TC) for control and treated rams at Siwa Oasis

Table 6: Averages \pm SE of ejaculate volume (EV, ml), sperm concentration (SC, $\times 10^9 \text{ml}^{-1}$) and total sperm output (TSO, $\times 10^9 \text{ml}^{-1}$) of Barki rams fed GDP in CFM during different seasons

Hormone	Group	Summer	Autumn	Winter	Spring	Overall mean
EV (ml)	C	1.03 \pm 0.01	1.12 \pm 0.01	0.98 \pm 0.01	0.98 \pm 0.01	1.03 \pm 0.010 ^B
	T	1.03 \pm 0.01	1.12 \pm 0.01	1.03 \pm 0.01	1.04 \pm 0.01	1.05 \pm 0.010 ^A
	Overall mean season	1.03 \pm 0.010 ^b	1.2 \pm 0.010 ^a	1.00 \pm 0.010 ^b	1.01 \pm 0.010 ^b	
SC ($\times 10^9 \text{ml}^{-1}$)	C	3.39 \pm 0.06	3.34 \pm 0.06	3.59 \pm 0.06	3.57 \pm 0.06	3.47 \pm 0.030 ^A
	T	3.03 \pm 0.10	3.42 \pm 0.06	3.48 \pm 0.06	3.55 \pm 0.06	3.37 \pm 0.030 ^B
	Overall mean season	3.22 \pm 0.043 ^c	3.38 \pm 0.043 ^b	3.54 \pm 0.043 ^a	3.56 \pm 0.043 ^a	
TSO ($\times 10^9 \text{ml}^{-1}$)	C	3.52 \pm 0.08	3.74 \pm 0.08	3.50 \pm 0.08	3.51 \pm 0.08	3.60 \pm 0.042
	T	3.11 \pm 0.08	3.82 \pm 0.08	3.57 \pm 0.08	3.66 \pm 0.08	3.54 \pm 0.042
	Overall mean season	3.32 \pm 0.061 ^c	3.78 \pm 0.061 ^a	3.53 \pm 0.061 ^b	3.78 \pm 0.061 ^b	

C = control group, T = treated group, GDP = ground date palm, CFM = concentrate feed mixture

^{a,b,c} values marked with different letters in row are significantly different ($\alpha=P<0.05$)

^{A,B} values marked with different letters in column are significantly different ($\alpha=P<0.05$)

Semen Physical Characteristics

Ejaculate Volume, Sperm Concentration and Total Sperm Output

The obtained results in Table 6 indicated that SC values of both groups throughout the four seasons lay in ranges of previous determined values by Hafez and Hafez [50] who reported that the sperm concentration of an ejaculate ranges from 3.5 to $6.0 \times 10^9 \text{ml}^{-1}$ in rams. In accordance, Asadpour [51] found that the mean ejaculate volume recorded of four cross breed rams, ranged between 1.0 and 1.4 ml, with the mean sperm concentration between 3.3 - $4.7 \times 10^9 \text{ml}^{-1}$. Also, Gil *et al.* [52] considered a concentration of $2.5 \times 10^9 \text{ml}^{-1}$ to be normal and acceptable. Regardless the effect of season, the results revealed that, treated rams demonstrated a higher EV (1.05 ± 0.010) compared with control rams ($1.03 \pm 0.010 \text{ml}$). Statistical analysis showed that treatment has significant ($P<0.05$) effect on EV. Results indicated that SC followed a trend opposite to that of the ejaculate volume. Therefore, control rams were superior ($P<0.05$) in

SC and the calculated TSO (3.47 ± 0.030 and 3.60 ± 0.042) compared with treated rams ($3.37 \pm 0.030 \times 10^9 \text{ml}^{-1}$ and $3.54 \pm 0.042 \times 10^9 \text{ml}^{-1}$). In accordance, Talebi *et al.* [53] found that SC of Markhoz bucks followed a trend opposite to that of the EV. As shown in Fig. 3, the highest EV was recorded in the middle of summer season (July) and autumn months (September-November). Concerning the effect of season, results indicated that the largest semen volume and the calculated total sperm output (volume \times concentration) were recorded in autumn months in both control and treated groups. Also, TSO followed a trend similar to that of the ejaculate volume on all seasons. Similarly, Karagiannidis *et al.* [54], Barakawi *et al.* [55] and Talebi *et al.* [53] found that TSO followed a trend similar to that of EV which being higher ($P<0.05$) during autumn. Sarlós *et al.* [45] found that ejaculate volume tended to increase from spring ($0.52 \pm 0.03 \text{ml}$) to autumn ($0.88 \pm 0.03 \text{ml}$) and the lowest sperm concentration ($4.92 \pm 0.13 \times 10^9 \text{ml}^{-1}$) was measured in winter and the

highest in summer ($6.56 \pm 0.21 \times 10^9 \text{ ml}^{-1}$) while total sperm count per ejaculate was the highest in autumn ($5.22 \pm 0.45 \times 10^9 \text{ ml}^{-1}$) in Racka rams. On the contrary, Mittal and Ghosh [56] and Chemineau [57] reported that total sperm per ejaculate did not differ between seasons in goats.

It is worthy to note that, there was a slight decrease in EV, SC and TSO in both groups at August month (0.97, 2.51 and 2.44 vs. 0.97, 2.58 and 2.71) for control and treated groups, respectively this reduction may be attributed to the effect of high ambient temperature (40.5°C) and low relative humidity (51.4%) in August month (Table 1). On the other hand, the elevation in EV, SC and TSO in both groups in November month (1.10, 3.42 and 3.76 vs. 1.12, 3.33 and 3.72) for control and treated groups respectively may be due to the higher value in plasma TC. Casady *et al.* [58] and Lodge and Salisbury [59] resulted in decreased sperm output and more abnormal sperm. On the contrary Mohamed *et al.* [60] reported that SC increased significantly in un-shaded desert rams during summer season. Results in Table 6 indicated that EV, SC and TSO followed approximately the same profile as plasma testosterone (TC) with group differences being more pronounced in treated group. This result was in agreement with work done by Gastel *et al.* [61]. Also, Dickerson and Sanford [62] indicated that there was relationship between testosterone concentration and sperm output.

Sperm Mass Motility and Sperm Progressive Motility:

Means \pm SE of sperm mass motility (SMM) and sperm progressive motility (SPM) for control and treated groups during the whole year are presented in Table 7. Regardless the effect of season, the results indicated that, the overall means of SMM and SPM were higher in treated (3.90 ± 0.066 and 81.20 ± 0.174) than control (3.62 ± 0.066 and 80.4 ± 0.066) rams. Statistical analysis showed that there were significant ($P < 0.05$) effects of treatment on SMM and SPM. The rate of changes in SMM and SPM exhibited about 8.33 and 1.5% higher levels in treated than in control rams for SMM and SPM, respectively. Regarding the effect of season, SMM and SPM values were significantly affected by season ($P < 0.05$) in both control and treated groups, where SMM and SPM values were higher during autumn months followed by summer season. In accordance, Talebi *et al.* [53] reported increase in the gross and progressive sperm during the summer and autumn, followed by a significant ($P < 0.05$) decrease during winter and spring seasons, which is consistent with Karagiannidis *et al.* [54] and

Barkawi *et al.* [55], who reported mass and progressive sperm motility to increase from winter and spring to summer and autumn seasons in Alpine and Zaraibi goats, respectively. On the contrary, Ahmed *et al.* [63] found no significant effect of season on sperm mass motility. Galil and Galil [64] and Mohamed and Abdelatif [65] found a significantly ($P < 0.01$) lower in SMM with all levels feeding during summer compared to winter values and they attributed this reduction to the high ambient temperature and increase in body temperature of rams during summer season. In other studies semen sample had a higher mass motility in autumn season [66, 43]. Also, Karagiannidis *et al.* [67] found that the sperm progressive motility was lower during summer compared to the other three seasons of the year in Chios and Friesian rams.

Live Sperm Percentage and Semen pH: Averages of LSP control and treated rams during four seasons are presented in Table 6. Results indicated that treatment had significantly ($P < 0.05$) effect on LSP. The overall means of LSP recorded (80.70 ± 0.232 and $82.0 \pm 0.232\%$) for control and treated groups, respectively. Season affected ($P < 0.05$) the average LSP, being the highest values were observed in both control ($83.1 \pm 0.46\%$) and treated ($85.3 \pm 0.46\%$) groups during autumn compared with the other seasons. Talebi *et al.* [53] found that the percentage live sperm was significantly higher ($P < 0.05$) during autumn and summer, while dead sperm values were higher during winter and spring seasons. Similar trend has been reported by Barkawi *et al.* [55] and Ahmed *et al.* [63], in Saanen and Zaraibi goats, respectively. In contrast, Loubser and Niekerk [68] reported that the percentage live and normal sperm per ejaculate did not change significantly between seasons. Averages of semen pH of control and treated rams during four seasons are presented in Table 6. Results indicated that semen pH values were not significantly ($P > 0.05$) affected by treatment. The overall means recorded 6.84 ± 0.024 and 6.80 ± 0.024 for control and treated groups, respectively. Semen pH values in the present study were slightly acidic. It was similar to the determined values for Rayini goats [69] and Zaraibi goats [55]. Our results showed that monthly changes in semen pH were not remarked in both control and treated groups. Regarding the effect of season, throughout the duration of study results indicated that no seasonal variations observed in semen pH over the four seasons. Lastly, the semen quality, as measured by some physical characteristics was the better during summer and autumn than winter and spring seasons at Siwa Oasis, Egypt.

Table 7: Means \pm SE of sperm mass motility (SMM), sperm progressive motility (SPM), live sperm percentage (LSP) and semen pH of Barki rams fed GDP in CFM during different seasons

Hormone	Group	Summer	Autumn	Winter	Spring	Overall mean
SMM	C	3.8 \pm 0.13	4.13 \pm 0.13	3.2 \pm 0.13	3.33 \pm 0.13	3.62 \pm 0.066 ^B
	T	3.7 \pm 0.13	4.43 \pm 0.13	3.73 \pm 0.13	3.80 \pm 0.13	3.90 \pm 0.066 ^A
	Overall mean season	3.75 \pm 0.094 ^b	4.28 \pm 0.094 ^a	3.47 \pm 0.09 ^c	3.57 \pm 0.094 ^{bc}	--
SPM	C	82.8 \pm 0.35	83.1 \pm 0.35	77.7 \pm 0.35	78.0 \pm 0.35	80.4 \pm 0.174 ^B
	T	82.47 \pm 0.35	84.4 \pm 0.35	78.8 \pm 0.35	79.23 \pm 0.35	81.2 \pm 0.174 ^A
	Overall mean season	82.62 \pm 0.25 ^b	83.75 \pm 0.25 ^a	78.2 \pm 0.25 ^b	78.62 \pm 0.25 ^b	--
LSP	C	80.2 \pm 0.46	83.1 \pm 0.46	80.4 \pm 0.46	79.3 \pm 0.46	80.7 \pm 0.232 ^B
	T	81.4 \pm 0.46	85.3 \pm 0.46	80.8 \pm 0.46	80.7 \pm 0.46	82.0 \pm 0.232 ^A
	Overall mean season	80.80 \pm 0.30 ^b	84.17 \pm 0.30 ^a	80.62 \pm 0.30 ^b	79.98 \pm 0.30 ^b	--
PH	C	6.87 \pm 0.05	6.84 \pm 0.05	6.87 \pm 0.05	6.80 \pm 0.05	6.84 \pm 0.024
	T	6.82 \pm 0.05	6.76 \pm 0.05	6.82 \pm 0.05	6.74 \pm 0.05	6.80 \pm 0.024
	Overall mean season	6.85 \pm 0.034	6.81 \pm 0.034	6.85 \pm 0.034	6.76 \pm 0.034	--

C = control group, T = treated group, GDP = ground date palm, CFM = concentrate feed mixture

^{a,b,c} values marked with different letters in row are significantly different (^a=P<0.05)^{A,B} values marked with different letters in column are significantly different (^A=P<0.05)

CONCLUSION

It can be concluded that, partial substitution of ground yellow corn (GYC) by ground date palm (GDP) at 50% (w/w) level could improve semen quality since the results showed that important semen characteristics such as EV, SC, SMM, SPM and TSO were slightly improved at 50% level (wt/wt) substitution of GYC in CFM with GDP. Moreover, although high ambient temperatures during summer and autumn months and particularly in August month, control and treated rams produced semen of superior quality and quantity characteristics which indicated that rams could cope with such desert condition of Siwa Oasis.

REFERENCES

- Alkhateeb, A.A. and H.M. Ali-Dinar, 2001. Date palm (*Phoenix dactylifera*): Production and research in Kingdom of Saudia Arabia. The date palm international Symposium, Windhoek, Namibia.
- Nunes, C.S., 1994. Microbial probiotics and their utilization in husbandry. Revista Portuguesa de Ciencias Veterinarias, 89: 166-174.
- El-Nakhal, H.M., M.I. El-Shaarawy and A.S. Messallam, 1989. "Tamrheeb" a new protein rich product from daters. Proceeding of Second Symposium on the Date Palm, Saudi Arabia.
- Al-Dobaib, S.N., M.A. Mehaia and M.H. Khalil, 2009. Effect of feeding discarded dates on milk yield and composition of Ardi goats. Small Rumin. Res., 81: 167-170.
- Cogburn, L.A., N.C. Mao, S. Agrawal and J. Burnside, 1995. Interaction between somatotrophic and thyrotrophic axes in regulation of growth and development of broiler chickens. Arch. Geflugel. Sonderh., 1: 18-21.
- Aller, J.F., D. Aguilar, T. Vera, G.P. Almeida and R.H. Alberio, 2012 Seasonal variation in sexual behavior, plasma testosterone and semen characteristics of Argentine Pampinta and Corriedale rams. Spanish Journal of Agricultural Research, 10(2): 345-352.
- Avdi, M., G. Banos, K. Stefos and P. Chemineau, 2004. Seasonal variation in testicular volume and sexual behavior of Chios and Serres rams. Theriogenology 62: 275-282.
- Schanbacher, B.B. and D.D. Lunstra, 1976. Seasonal changes in sexual activity and serum levels of LH and testosterone in Finnish Landrace and Suffolk rams. J. Anim. Sci. 43: 644-650.
- Mukasa-Mugerwa, E. and Z. Ezaz, 1992. Relationship of testicular growth and size to age, body weight and onset of puberty in Menz ram lambs. Theriogenology, 38: 979-988.
- Almeida, G., R. Alberio and J.J. Murtagh, 1981. Estudio de las variaciones de la actividad reproductiva en un grupo de carneros Corriedale a lo largo de un año. Producción Animal 8: 343-354. [In Spanish].
- Perez, C., A. Lopez, A. Castrillejo, A. Bielli, D. Laborde, T. Gastel, R. Tagle, D. Queirolo, J. Franco, M. Forsberg, H. Rodriguez-Martinez, 1997. Reproductive seasonality of Corriedale rams under extensive rearing conditions. Acta Vet. Scand., 38: 109-117.

12. Oláh, J., S. Kusza, S. Harangi, J. Pasta, A. Kovacs and A. Pecs, 2013. Seasonal changes in scrotal circumference, the quantity and quality of ram semen in Hungary. *Arch. Tierzucht.*, 56(10): 102-118.
13. Pourseif, M.M., G.H. Moghaddam, S.A. Rafat, H. Daghighkial and A. Pourseif, 2013. Photoperiod as a Factor for Studying Fluctuations of Seminal Traits during Breeding and Non-Breeding Season. *Iranian Journal of Applied Animal Sci.*, 3(2): 313-321.
14. Hafez, E.S.E., 2004. Anatomia da Reproducao Masculina. In: Hafez E.S.E. & Hafez, B., *Reproducao Animal*. 7th Ed. Manole, Barueri, Brazil, pp: 3-12. (In Portuguese).
15. Boland, M.P., A.A. Al-kamali, T.F. Crosby, Al-kamali, N.B. Haynes and C.M. Howles, 1985. The influence of breed, season and photoperiod on semen characteristics, testicular size, libido and plasma hormone concentration in rams. *Animal Reproduction Science*, 9: 241-252.
16. Zamiri, M.J. and H.R. Khodaei, 2005. Seasonal thyroidal activity and reproductive characteristics of Iranian fat-tailed rams. *Anim. Reprod. Sci.*, 88: 245-255.
17. Kearl, L.C., 1982. Nutrient Requirement of Ruminants in Developing Countries. *Utah Agric. Exp. Sta. Utah State University, Logan, USA*.
18. A.O.A.C., 1995. Official Methods of Analysis. Association of Analytical Chemists. Washington, D.C.
19. Evans, G. and W.M.C. Maxwell, 1987. *Salamon's Artificial Insemination of Sheep and Goats*. Butterworths, Sydney, Australia, pp: 194.
20. Kicklighter, E.J. and R.J. Norman, 1989. The gonads. *Clinical Chemistry*, 43: 658-660.
21. Barker, F.S. and R.E. Silvertown, 1982. *Introduction to Medical Laboratory Technology*. 5th Ed. Publ. Butterworth S.C London, pp: 481-494.
22. S.A.S., 1998. Statistical Analysis Systems, STAT/ User's Guide, Release 603 Ed. SAS Institute, CaryNC. USA.
23. Duncan, D.B., 1955. Multiple Ranges and Multiple F test. *Biometrics*, 11: 1-42.
24. Al-Dabeeb, S.N., 2005. Effect of feeding low quality date palm on growth performance and digestion coefficients in fattening Najdi sheep. *Small Ruminant Research*, 57: 37-42.
25. Alhomidy, S.N., S. Basmaeil, A.N. Al-Owaimer, A.M. El-Waziry and M. Koohmaraie, 2011. Effect of feeding different amounts of discarded dates on growth and efficiency of digestion in sheep. *Australian Journal of Basic and Applied Sciences*, 5(3): 636-640.
26. Al-Mutairi, S.E. and T. Ismail, 2001. The use of dates and residues in fattening young camels. *Development Research Center of Pasture and Livestock, Al-Jouf*.
27. Abdel-Fattah, M.S., Afaf. A. Abdel-Hamid, Ashgan M. Ellamie, M.M. El-Sherief and M.S. Zedan, 2012. Growth Rate, Some plasma biochemical and amino acid concentrations of Barki lambs fed ground Date Palm at Siwa Oasis, Egypt. *American-Eurasian J. Agric. & Environ. Sci.*, 12(9): 1166-1175.
28. Mousa, I.A. and M.Y. Al-Saiady, 2002. Thyroid hormones levels in growing male camels fed different levels of commercial feeds. *J. King. Saud. Univ., Agric. Sci.*, 14(2): 71-76.
29. Al-Furaiji, M.M., S.M. Basmaeil and M.H. Gamil, 1994. A Note Relationship of Plasma Thyroxine and Triiodothyronine Rate to Body Weight in Growing Male Camels. *Anim. Prod.*, 59: 460-462.
30. Shalaby, T.H., 1985. Performance and adaptation of local sheep to varied environmental and managerial conditions. Ph.D. Thesis, Faculty of Agric. Cairo Univ. Egypt.
31. Yousef, M.K. and H.D. Johnson, 1985. Endocrine System and Thermal Environment. In: *Stress Physiology in Livestock*, edited by M.K. Yousef, CRC Press Inc. Boca, Florida, USA, 1: 133-154.
32. Habeeb, A.A., I.F.M. Marai and T.H. Kamal, 1992. Heat Stress in Farm Animals and the Environment. Edited by C. Philips and D. Piggens. CAB International, pp: 27-47.
33. Shalaby, T.H. and E.I. Shehata, 1994. Effect of dietary energy level and heat stress on physiological responses of Finn crossbred ewes. *Proceedings of 5th Scientific Conference on Animal Nutrition, Suez Canal Univ. Ismailia, Egypt*, 1: 87-93.
34. Marai, I.F.M., T.H. Shalaby, L.B. Bahgat and M.A. Abdel-hafez, 1997. Fattening of lambs on concentrates mixture diet alone without roughages or with addition of natural clay under subtropical conditions of Egypt. *Physiological reactions. Proceedings of International Conference on Animal Production and Health. Dokki, Cairo, Egypt*.
35. Guerrini, V.H. and H. Bartchinger, 1983 Effect of exposure to a hot humid and a hot-dry environment on thyroid hormone values in sheep. *British Veterinary Journal*, 139: 119-128.

36. Buys, N., R. Peeters, B. De Clerck, J. Van Isterdael, E.R. Kuhn and E. Decuyper, 1990. Seasonal variations in prolactin, growth hormones and thyroid hormones and the prolactin surge at ovulation do not affect litter size of ewes during pregnancy in the oestrous or the anoestrous season. *J. Reprod. and Fert.*, 90: 47-53.
37. Todini, L., A. Lucaroni, A. Malfatti, A. Debenedetti and S. Costarelli, 1992. Male-female differences in the annular profiles of the thyroid hormones blood level by the goat. *Atti della Societa Italiana della Scienze Veterinarie*, 46: 169-173.
38. Rhind, S. and S.R. McMillen, 1995. Seasonal changes in systemic hormone profiles and their relationship to patterns of fiber growth and molting in goats of contrasting genotypes. *Aust. J. Agric. Res.*, 46: 1273-1283.
39. Taha, T.A., E.I. Abdel-Gawad and M.A. Ayoub, 2000. Monthly variations in some reproductive parameters of barki and awassi rams throughout 1 year under subtropical conditions. 1-Semen characteristics and hormonal levels. *Anim. Sci.*, 71: 317-324.
40. Todini, L., A. Malfatti, A. Valbonesi, M. Trabalza-Marinucci and A. Debenedetti, 2007. Plasma total T3 and T4 concentrations in goats at different physiological stages, as affected by the energy intake. *Small Ruminant Research*, 68: 285-290.
41. Tajagookeh, H.D., A.Z. Shahneh, M.M. Shahrehabak and M. Sakeri, 2007. Monthly variation of plasma concentrations of testosterone and thyroid hormones and reproductive characteristics in three breeds of Iranian fat-tailed rams throughout one year. *Pak. J. Biol. Sci.*, 10(19): 3420-3424.
42. Todini, L., 2007. Thyroid hormones in small ruminants: effects of endogenous, environmental and nutritional factors. *Animal*, 1(7): 997-1008.
43. Gündogan, M., 2007. Seasonal variation in serum testosterone, T3 and andrological parameters of two Turkish sheep breeds. *Small Rumin. Res.*, 67: 312-316.
44. Mandiki, S.N.M., G. Deriske, J.L. Bister and R. Paquay, 1998. Influence of season and age on sexual maturation parameters of Texel, Suffolk and Ile-de-France rams. 1. Testicular size, semen quality and reproductive capacity. *Small Rumin. Res.*, 28: 67-79.
45. Sarlós, P., I. Egerszegi, O. Balogh, A. Molnár, S. Cseh and J. Rátky, 2013. Seasonal changes of scrotal circumference, blood plasma testosterone concentration and semen characteristics in Racka rams. *Small Ruminant Research*, 111(1): 90-95.
46. Delgadillo, J.A. and P. Chemineau, 1992. Abolition of the seasonal release of luteinizing hormone and testosterone in Alpine male goats (*Capra hircus*) by short photoperiodic cycles. *J. Reprod. Fert.*, 94: 45-55.
47. Benia, A.R., K. Taibi, A. Ait-Amrane, T. Belhamiti, S.M. Hammoudi and R. Kaidi, 2013. Study of seasonal sexual activity variations in Algerian rams: Sexual behaviour, testosterone concentration control and environmental factors. *African J. Biotechnology*, 12(41): 6042-6048.
48. Kaya, A., C. Yildiz, N.C. Lehimcioglu, A. Ergin and M. Aksoy, 1999. Seasonal variation in sperm quality, testicular size and plasma testosterone concentrations in Konya Merino rams. *J. Cent. Anim. Res. Int.*, 9: 1-5.
49. Keskin, E. and T. Kececi, 2001. Blood serum thyroid hormone levels and rumen protozoa in Merino rams at different environmental temperatures. *Tr. J. Vet. Sci.*, 17: 115-118.
50. Hafez, B. and E.S.E. Hafez, 2000. *Reproduction in Farm Animals*. 7th Ed., Lippincott Williams and Wilkins, New York, pp: 509.
51. Asadpour, R., 2012. Relationship between mineral composition of seminal plasma and semen quality in various ram breeds. *Acta Scientiae Veterinariae*, 40(2): 1027.
52. Gil, J., N. Lundeheim, L. Söderquist and H. Rodriguez-Martinez, 2003. Influence of extender, temperature and addition of glycerol on post-thaw sperm parameters in ram semen. *Theriogenology*, 59: 1241-1255.
53. Talebi, J., M. Souri, A. Moghaddam, I. Karimi and M. Mirmahmoodi, 2009. Characteristics and seasonal variation in the semen of Markhoz bucks in Western Iran. *Small Ruminant Research*, 85: 18-22.
54. Karagiannidis A., S. Varsakeli and G. Karatzas, 2000. Characteristics and seasonal variations in the semen of Alpine, Saanen and Damascus goat bucks born and raised in Greece. *Theriogenology*, 53: 1285-1293.
55. Barkawi, A.H., E.H. Elsayed, G. Ashour and E. Shehata 2006. Seasonal changes in semen characteristics, hormonal profiles and testicular activity in Zaraibi goats. *Small Rumin. Res.*, 66: 209-213.
56. Mittal, J.P. and P.K. Ghosh, 1985. Characteristics of Parbastar breed of goats from Rajasthan desert. *Indian J. Anim. Sci.*, 55: 673-678.

57. Chemineau, P., 1986. Sexual behavior and gonadal activity during the year in the tropical Creole meat goat, II-male mating behavior, testis diameter, ejaculate characteristics and fertility. *Reprod. Nutr. Dev.*, 26: 453-460.
58. Casady, R.B., R.M. Myers and J.E. Legates, 1953. The effect of exposure to high ambient temperature on spermatogenesis in the dairy bull. *J. Dairy Sci.*, 36: 14-23.
59. Lodge, J.R. and G.W. Salisbury, 1970. Seasonal Variation and Male Reproductive Efficiency. In A. D. Johnson, V.V. R. Gomes and N. L. Van Demark (Ed.) *The Testis*. Vol. III., Academic Press, New York.
60. Mohammed, S.S., A.M. Abdelatif and A.A.G. Adam, 2012. Effects of exposure to solar radiation on thermoregulation and semen characteristics of Sudanese Desert Rams (*Ovis aries*). *Global Vet.*, 9: 502-507.
61. Gastel, T., A. Bielli, R. Pere, A. Lopez, A. Castrillejo, R. Tagle, J. Franco, D. Laborde, M. Forsberg and H. Rodrigue-Martinez, 1995. Seasonal variations in testicular morphology in Uruguayan Corriedale rams. *Anim. Reprod. Sci.*, 40: 59-75.
62. Dickson, K.A. and L.M. Sanford, 2005. Breed diversity in FSH, LH and testosterone regulation of testicular function and in libido of young adult rams on the southeastern Canadian Prairies. *Small Ruminant Research*, 56: 189-203.
63. Ahmed, M.M.M., S.A. Makawi and A.A. Gadir, 1997. Reproductive performance of Saanen bucks under tropical climate. *Small Ruminant Research*, 26: 151-155.
64. Galil, K.A.A. and A.K.A. Galil, 1982. Seasonal variation in some semen characteristics of ejaculated spermatozoa of Sudan desert sheep in the tropics. *J. Agric. Sci. Camb.*, 99(1): 39-43.
65. Mohammed, S. Suhair and A.M. Abdelatif, 2010. Effects of level of feeding and season on thermoregulation and semen characteristics in desert rams (*Ovis aries*). *Global Veterinaria*, 4(3): 207-215.
66. Kafi, M., M. Safdarian and M. Hashemi, 2004. Seasonal variation in semen characteristics, scrotal circumference and libido of Persian Karakul rams. *Small Rumin. Res.*, 53: 133-139.
67. Karagiannidis, A., S. Varsakeli, C. Alexopoulos and I. Amarantidis 2000a. Seasonal variation in semen characteristics of Chios and Friesian rams in Greece. *Small Rumin. Res.*, 37: 125-130.
68. Loubser, P.G. and C.H. Van Niekerk, 1983. Seasonal changes in sexual activity and semen quality in the Angora ram. 2. Semen volume, quality and freezability. *S. Afric. J. Anim. Sci.*, 13: 161-163.
69. Zamiri M.J., H.R. and Heidari, 2006. Reproductive characteristics of Rayini male goats of Kerman province in Iran. *Anim. Reprod. Sci.*, 96: 176-185.