Reproductive Efficiency of Damascus Goats in Salt-Affected Lands in South Sinai, Egypt

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Abstract: The objective of this study was to investigate the impact of salinity in feed and drinking water on the reproductive and productive efficiency of Damascus goats under saline conditions of South Sinai, Egypt. Forty eight adult female Damascus goats were assigned randomly into equal four groups. The first group (G1) fed berseem (*Trifoliumalexandrnum*) hay (BH) and drank fresh water (247 ppm), the second group (G2) fed BH hay and drank saline water (6000 ppm), the third group (G3) fed salt-tolerant alfalfa (*Medicago sativa*) and drank fresh water (247 ppm) and the fourth group (G4) fed alfalfa and drank saline water (6000 ppm). Body weight changes, reproductive and productive traits and hormonal profile (estradiol-17β and progesterone) were measured. Chemical composition of the experimental roughages showed that alfalfa contained higher percentage of Na, K, Ca and P compared to BH. The results indicated that goats fed alfalfa had higher conception rate (85%) and twining rate (1.65 %) compared with goats fed BH (80%) and (1.45), respectively. Type of roughages feeding (hay and/or alfalfa) had non-significant effect on birth weight, while weaning weight significantly increased ($P \leq 0.05$) in BH groups. Milk yield negatively impacted ($P \leq 0.05$) by saline water with about 36% lower than fresh water, while type of roughages had no effect on milk production. Although plasma E2 levels were insignificantly affected by type of roughages, it was higher during pregnancy in alfalfa groups (G3 & G4) than BH groups (G1 & G2). Moreover, serum P4 concentration didn't affected by type of roughages. Our results indicated that utilization of salt-tolerant alfalfa as animal feeds in salt affected lands could be an appropriate option for alleviating the desertification problems. In addition, they provide alternative good feed resources particularly in summer and autumn seasons when the other conventional forage resources are shortage.

[Abdalla, E. B; Gawish, H. A.; El-Sherbiny, A. M.; Ibrahim , N. H. and El-Hawy, A.S. **Reproductive Efficiency of Damascus Goats in Salt-Affected Lands in South Sinai, Egypt.** *Am Sci* 2013;9(8):170-177]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 25

Keywords: Salt-Tolerant alfalfa, Saline water, Productive and Reproductive traits, Damascus goats.

1. Introduction

Populations in the developing countries are growing so quickly that the arable lands and the available fresh water are unable to sustain their needs. It was estimated from the various available data that globally the world is losing at least 3 ha of arable land every minute because of soil salinity **(Anon, 2006)**. In Egypt, about 95% of the land is desert, where the soil is sandy and most of the available ground-water is too saline to raise and sustain conventional crops **(Ashour *et al*., 1997)**. On the other hand, shortage of feed resources is a common characteristic in arid and semi-arid regions and is considered the main constraint to improve livestock productivity. Therefore, intensive efforts have been directed to find alternative feed resources from saline-tolerant plants **(El-Shaer, 2006)**.

The vegetative yields of halophytes and other salt-tolerant plants species could have great potentialities particularly as sources of livestock fodders. The fodder quality of these plants depends on a combination of climatic, soil, and plant factors. However, the value of certain salt-tolerant forage crops has been recognized by their incorporation in the rangelands improvement programs in many salt-affected regions throughout the world **(Anon, 2009)**.

On the other side, the combination of salt in feed and water is of critical importance. When the high salt intake comes from feed alone, and there is an unlimited supply of fresh water, the animal can cope by increasing water intake and therefore increasing the salt excreting capacity of the kidneys. This cannot be done if the salt is present in both feed and water. This has significant practical consequences; any level of salt in drinking water will compound the effects of a high dietary salt intake. Such an interaction is likely to be more important during the hotter, dry periods of the year than during colder, wetter times of the year **(Wilson, 1975)**.

National Research Council (2005) defined the "maximum tolerable levels" of sodium chloride in the diet (i.e., the levels that will not impair health and performance), as 3–6% for ruminants and 2–3% for swine and poultry. Studies on sodium chloride in drinking water indicated the order of tolerance as camels > sheep = goats > cattle > horses > pigs > poultry **(Ru *et al*., 2000** and **McGregor, 2004)**. The local Bedouin and Damascus goats are the dominant types of goats in Sinai, but these animals usually suffer from malnutrition, especially during the nutritionally critical periods of their reproductive cycle **(AL-Sheikh *et al.*, 2006** and **Badawy and Yousef, 2008**).

The aim of this study was to investigate the impact of salinity in drinking water and salt-tolerant plant (alfalfa) on the reproductive and productive performance of Damascus goats under arid conditions in South Sinai, Egypt.

2. Materials and Methods

This study was carried out during the period from August 2009 to July 2010 at Ras Sedr Research Station, South Sinai governorate that belongs to the Desert Research Center, Ministry of Agriculture and Land Reclamation, Egypt.

Forty eight adult female Damascus goats (2.0 - 2.5 years old with average body weight (27.8 ± 3.22kg) were assigned randomly into equal four groups (12 for each). The first group (G1) was served as control fed berseem (*Trifolium alexandrnum*) hay (HB) and drank fresh water (247 ppm), the second group (G2) fed berseem (BH) and drank saline water (6000 ppm), the third group fed salt-tolerant plant (alfalfa) and drank fresh water and the fourth group fed alfalfa and drank saline water. All groups were offered concentrate feed mixture as a 125% of maintenance requirements. Rations were adjusted monthly to cover their requirements during their physiological status according to **Kearl (1982)**. Water was available to all groups daily.

Animals were kept in semi-open pens roofed with wood, and were clinically healthy and free from internal and external parasites.

Mating season started in October 2009 and lasted for 42 days (equal to 2 estrous cycles). Five fertile bucks were allowed to rotate among different goat groups to avoid sire/group confounding effect. Bucks were fed the control concentrate ration and removed from the goat groups at early morning before offering rations. The following reproductive traits were recorded:

- Conception rate and kidding rate as a percentage of goats joined.
- Average litter size.

Once kidding took place, the born kids were earring tagged and weighed to record their birth weight. Kids were left with their dams till 3 months (90 days), and then weaned, and weaning weight was recorded and adjusted for 90 days.

Milk yield was determined biweekly from lambing up to 12 weeks lactation period, representing early (2^{nd} & 4^{th} week), mid (6^{th} & 8^{th} week) and late lactation periods (10^{th} & 12^{th} week), through the complete hand milking after fasting of kids for 12 hours for two consecutive days one at night and the next at morning to cover 24 hours (Abdalla et al., 2007).

Milk samples (50 ml) were randomly taken biweekly from 5 animals within each respective group during 12 weeks lactation period, in plastic bags and kept under -20 ^{0}C for further analysis. Chemical composition of milk in terms of fat, protein, lactose, total solids and solids not fat was determined using milk scan system (Bently - Belgium).

During mating season, blood samples from 6 goats of each group were collected through vein puncture (using clinical needle) at 0, 3, 7, 11, 17 and 20 days from day of estrus (day 0) and then biweekly interval up to parturition. Blood samples were centrifuged at 3000 rpm for 15 min to separate serum and kept at -20^{o}C until analysis.

Estradiol-17β and progesterone were measured by ELISA method using IMMUNOSPEC kits supplied by Immunospec Corporation, 7018 Owensmounth Ave. Suite 103 Canoga Park, CA 91303, USA.

Statistical analysis:

Data of estrus activity was analyzed using "all or non traits" according to **Snedecor and Chocran (1980)**, while continuous data were subjected to an analysis of variance utilizing GLM model of **SAS (1998)** for repeated measurements and means were compared using Duncan Multiple Range Test **(Duncan 1955)**.

3. Results and Discussion

Chemical composition of the experimental roughages and concentrate feed mixture:

According to the roughage types, salt-tolerant alfalfa compared to berseem hay contained higher crude protein (CP), 18.8 vs. 14.5%, ether extract (EE) 2.51 vs. 1.38% and nitrogen free extract (NFE) 50.49 vs. 41.30% and lower crude fiber (CF) 20.63 vs. 28.2% and Ash (7.55 vs. 11.61%) as shown in Table (1). Similar results were reported by **El-Shaer *et al.*, (2001)** and **Ben Salem *et al.*, (2005)**. While, percentage of Na (1.40 vs. 0.70%), K (1.72 vs. 1.24%), Ca (0.962 vs. 0.682%) and P (0.666 vs. 0.233%); concentrations were higher in alfalfa than berseem hay, respectively. These differences may possibly due to maturity differences in alfalfa used in this experiment. Such results are in agreement with those reported by **Karabulut *et al.*, (2006)** and in disagreement with **Fayed *et al.*, (2010).**

The previous results in the same laboratory **(Fayed *et al.*, 2010)** indicated that the apparent digestibility of OM, CF, NFE were higher with fresh alfalfa compared to berseem hay. On the other hand, data in Table (1) showed that mineral concentration levels of Na, K, Ca and P were higher than probable dietary requirements for Na, (0.9 – 0.18%), K (0.50 – 0.80%), Ca, (0.36 – 0.42%) and P, (0.29 – 0.31%), respectively **(National Research Council, 1980)**. Although concentrations were higher than the recommended levels, the concentrations are still within the maximum tolerance levels of Na, K, Ca and P (4.0, 2.0, 1.5 and 0.6%, respectively) for sheep and goats **(Kearl, 1982)**.

Reproductive performance of Damascus goat fed salt-tolerant alfalfa and drinking saline water:

Feeding Damascus goats on salt-tolerant plants diet from the time of mating up to parturition did not compromise reproductive efficiency. The alfalfa doe groups had scored higher conception rates (90 and 80%) compared to their counterparts fed traditional roughage (75 and 90%), respectively. Likewise, kidding rate was improved in alfalfa groups (91.7 and 83.3%) compared to their partners (75 and 83.3%) fed traditional roughage. The other reproductive traits were relatively similar with insignificant differences.

These results are in agreement with those reported by **Zarkawi *et al.*, (2005)** who reported that the reproductive performance of Awassi ewes did not affected by feeding salt-tolerant *Sesbania aculeate* with fertility rates being 80 and 72.7% for control and salt-tolerant groups, respectively. Likewise, **Shetaewi *et al.* (2001)** found that conception rate not differ significantly between Damascus goats fed on rice straw, green acacia and berseem hay, being 81.8%, 81.8% and 100% for the 3 groups, respectively. They also reported that kidding percentage tended to be higher in berseem hay group (90.9 %) than in green acacia group (72.7) or rice straw group (63.6%), but these differences were not significant.

Table (1): Chemical analysis of different experimental roughages and concentrate feed mixture (on 100% DM basis).

Chemical composition (%)	Experimental rations		
	AlfaAlfa	Hay	CFM
Dry Matter (DM)	75.35	88.8	89.66
Crude Protein (CP)	18.82	14.5	14.2
Crude Fiber (CF)	20.63	28.2	8.14
Ether extract (EE)	2.51	1.38	3.36
Nitrogen free extract (NFE)	50.49	41.3	69.74
Ash	7.55	11.61	4.56
Na (%)	1.40	0.70	0.631
K (%)	1.72	1.24	0.759
Ca (%)	0.962	0.682	0.359
P (%)	0.666	0.233	0.511

Table (2): Reproductive performance for different studies goat groups.

Item	Experimental groups			
	G1	G2	G3	G4
No. of doe joined	12	12	12	12
Conception rate, %	75	90	90	80
No. of does kidding	9	10	11	10
kidding rate, %	75^{c}	83.3^{b}	91.7^{a}	83.3^{b}
No. of kids borne alive	13	11	16	18
Average litter size	1.6	1.1	1. 3	1.5
No. of kids weaned	10	8	12	14
Percentage of kids weaned	76.9	72.7	75.0	77.8
Mortality rate (from birth to weaning), %	23.1	28.3	25	22.2

G1; (Hay + fresh water), G2;(Hay + saline water), G3;(Salt tolerant plant + fresh water) , G4;(Salt- tolerant plant + saline water).
Means within each row with different superscript are differed significantly at p≤0.05.
a- c within each row, least square means with different superscript differed significantly at P≤0.05.

In the present study, number of kids born alive recorded the highest value in G4 (18) then G3 (16) while the lowest value showed in G2 (11) while, G1 recorded 13 kids. Also number of kids weaned showed similar trend (14, 12, 11 and 10 weaned kids) for G4, G3, G2 and G1, respectively, indicated that salt-tolerant alfalfa did not affect negatively kids survival. Average litter size showed highest value in G1 (1.6) then G4 (1.5), while G2 recorded lowest value (1.1) and G3 recorded 1.3 as shown in Table (2). Mortality rate from birth to weaning was higher in G2 (28.3%); while, G4 recorded lowest value (22.2%), G1 recorded 23.1% and G3 recorded 25%. These values indicated that no differences between feeding berseem hay or salt-tolerant alfalfa on reproductive traits of Damascus goat. These results are in harmony with those reported by **Digby *et al.* (2008)** and **Zarkawi *et al.* (2005).**

Feeding with salt-tolerant Pawera red clover (*Trifolium subterraneum*) for 13 weeks before mating had no effect on the reproductive performance of New Zeland Romney ewes, whereas feeding ewes for a longer duration resulted in a lower ovulation rate and a higher percentage of barren individuals **(Shackell and Kelly 1984)**. The reason is that red clover contains oestrogenically active substances **(Kelly *et al.*, 1979)** affecting the menials in blood, a phenomenon of particular importance during pregnancy **(Palfii *et al.*, 1986)**.

Milk yield and milk composition of Damascus goats fed salt-tolerant alfalfa and drinking saline water:

Milk yield was significantly ($p \leq 0.05$) affected by both types of roughage and water (Table 3). Average daily milk yield was found to be 1198.3, 787.0, 1080.0 and 887.5 ml/h/d for G1, G2, G3, and G4 respectively. In the present study, milk yield recorded the highest values in fresh water groups (G1 and G3). Data indicated that saline water had negative effect on milk yield; the yield had decreased by 36% (Table 3), while type of feed did not effect on milk production. Milk production recorded high values in mid lactation than early and late lactation (Figure1). This result was nearest to 906.5 ± 85.13 ml/h/d obtained by **Abo Bakr (2012)** in the same breed.

The effect of dietary treatments on the goat milk composition is shown in Table (3). The total solids, fat and protein percentages differed insignificantly among treatments, whereas lactose percentages significantly differed ($P \leq 0.05$) in berseem hay groups compared to alfalfa groups. Feeding berseem hay resulted in more than two fold increase in milk production compared with feeding rice straw **(Shetaewi, 2001)**.

Growth performance of kids fed salt-tolerant alfalfa and drinking saline water:

Body weights of the kids from birth to weaning are presented in Table (4). Kid's birth weight of the different groups was found to be 2.43, 2.70, 2.78 and 2.95 kg for G1, G2, G3 and G4, respectively. Results showed that alfalfa and salty water group showed better values than their partners fed BH (2.86 vs. 2.57 kg) and fresh water groups (2.82 vs. 2.60) although differences were not significant. The results of the present study indicated that birth weight of Damascus kids was relatively higher than 2.49 kg reported by **Shetaewy *et al.* (2001).** However, produced kids with normal birth weight indicating the maternal ability to adequately regulate salt and water balance and adapt metabolically to the challenges associated with salt ingestion.

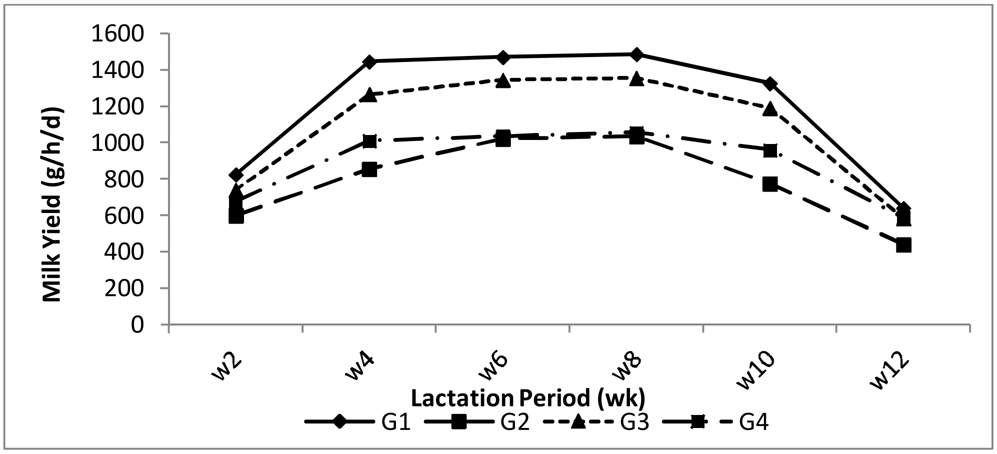
On the other hand, Overall means of weaning weight of Damascus kids were found to be 11.51 vs. 10.81 kg for BH and alfalfa groups and 11.66 vs. 10.66 kg for fresh and saline water groups with insignificant differences. However, weaning weight of BH groups (G1 and G2) was affected significantly ($P \leq 0.05$) by type of water. Values were 12.41 and 10.60 kg for G1 and G2, respectively. In contrast, alfalfa groups (G3 and G4) scored relatively similar weaning weight of 10.9 and 10.72 kg, respectively with insignificant differences. These results indicated that salt-tolerant alfalfa did not affect negatively on kids weight.

Growth rate, particularly in growing animals, is an important measurement for the evaluation of new feed resources because it represents the total effect of most feed properties.

Table (3): Effect of salt-tolerant plant and drinking water on milk yield and composition.

Traits	Experimental diets	Drinking water		Overall mean
		Tap water	Saline water	
Milk yield (gm/h/d)	Hay	1198.33^{a}±66.42	787.00^{b}±66.42	992.91^{A}±66.42
	STP	1080.00^{a}±66.42	887.50^{b}±66.42	983.7^{A}±66.42
Overall mean		1139.16^{A}±46.97	837.50^{B}±46.97	
Fat %	Hay	3.86^{a}±0.28	3.34^{a}±0.28	3.60^{A}±0.20
	STP	3.27^{a}±0.28	3.23^{a}±0.28	3.25^{A}±0.20
Overall mean		3.56^{A}±0.20	3.29^{A}±0.20	
Protein %	Hay	3.63^{a}±0.11	3.53^{a}±0.11	3.58^{A}±0.08
	STP	3.58^{a}±0.11	3.45^{a}±0.11	3.51^{A}±0.08
verall mean		3.60^{A}±0.08	3.94^{A}±0.08	
Lactose %	Hay	4.36^{ab}±0.19	4.58^{a}±0.19	4.16^{A}±0.14
	STP	4.22^{b}±0.19	4.21^{b}±0.19	4.22^{A}±0.14
Overall mean		4.29^{A}±0.14	4.53^{A}±0.14	
Ash %	Hay	0.68^{a}±0.04	0.62^{a}±0.04	0.64^{A}±0.03
	STP	0.71^{a}±0.04	0.70^{a}±0.04	0.70^{A}±0.03
Overall mean		0.68^{A}±0.03	0.66^{A}±0.03	
SNF %	Hay	8.61^{a}±0.32	9.01^{a}±0.32	8.81^{A}±0.22
	STP	8.51^{a}±0.32	8.37^{a}±0.32	8.44^{A}±0.22
Overall mean		8.56^{A}±0.22	8.59^{A}±0.22	
TS %	Hay	12.52^{a}±0.53	12.36^{a}±0.53	12.44^{A}±0.38
	STP	11.78^{a}±0.53	11.61^{a}±0.53	11.70^{A}±0.38
Overall mean		12.15^{A}±0.38	11.98^{A}±0.28	

a-b within eachrow, least square means with different superscript differed significantly at $p \leq 0.05$.
A-Bwithin eachcolumn, least square means with different superscript differed significantly at $p \leq 0.05$.



G1; (Hay + fresh water), G2;(Hay + saline water), G3;(Salt tolerant plant + fresh water) , G4;(Salt tolerant plant + saline water).

Figure (1): Milk yield of different goat groups over 12 weeks lactation period.

Fresh water as well as BH groups were relatively better than their partners of saline water and alfalfa, although differences were not significant (Table 4). However, concerning within treatment effect, drinking saline water was found to affect significantly (P≤0.05) average daily gain in BH (123.84 vs 105.72 g/h/d). These values were coincided with higher milk yield reported for the same respective groups (1198.3 and 1080.0 gm/h/d) compared with saline water groups (787.0 and 887.5 gm/h/d). Thus, weaning weight at 90 days old was found to be heavier in both G1 (12.41 kg) and G3 (10.90 kg) as compared to G2 (10.60 kg) and G4 (10.72 kg).

Table (4): Effect of salt tolerant plant and drinking water on kids body weight.

Traits	Experimental diets	Drinking water		Overall mean
		Tap water	Saline water	
Birth weight(kg)	Hay	2.43^{a}±0.19	2.70^{a}±0.25	2.57^{A}±0.16
	STP	2.78^{a}±0.23	2.95^{a}±0.16	2.86^{A}±0.14
Overall mean		2.60^{A}±0.15	2.82^{A}±0.15	
Weaning weight (kg)	Hay	12.41^{a}±0.56	10.60^{b}±0.72	11.51^{A}±0.43
	STP	10.90^{ab}±0.72	10.72^{b}±0.49	10.81^{A}±0.40
Overall mean		11.66^{A}±0.46	10.66^{A}±0.43	
Weight gain (gm)	Hay	123.84^{a}±5.63	105.72^{b}±7.19	114.78^{A}±4.38
	STP	108.66^{ab}±7.24	106.82^{b}±4.97	107.74^{A}±4.01
Overall mean		116.25^{A}±4.58	106.72^{A}±4.37	

a-b within each row, least square means with different superscript differed significantly at p≤0.05.
A-B within each column, least square means with different superscript differed significantly at p≤0.05.

Hormonal profiles during estrous cycle and gestation:

Estradiol-17β and progesterone of Damascus goat fed salt-tolerant alfalfa and drinking saline water:

Plasma E2 levels were insignificantly higher during estrus cycle in alfalfa groups compared to other groups due to that alfalfa contains estrogenically active substance (Figure 2). This finding agreed with those reported by **Shackell and Kelly (1984).** Serum E2 levels were peaked on the 1^{st} day of the cycle. This agreed with those results of **Gabr (1986)** and **Mandiki *et al.* (1990)**. The rapid decrease in plasma E2 observed during the luteal phase might be attributed to the inhibitory influence of the rapidly rising plasma P4 (from day 3-18 of the cycle), **Jain (1992)**. The present results are in agreement with those of **Aysel and Aysen (2003)**, who reported that plasma E2 levels did not significantly differ during estrus cycle.

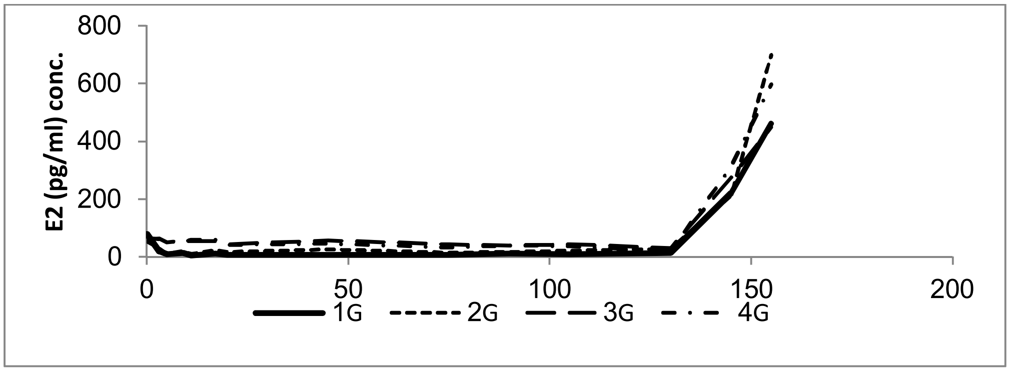


Figure (2): Estradiol-17β concentration (pg/ml) of different groups during gestation period.
G1; (Hay + fresh water), G2;(Hay + saline water), G3;(Salt tolerant plant + fresh water) , G4;(Salt tolerant plant + saline water).

Progesterone (P4) concentration was low (0.9 ±0.62 ng/ml) on the day of estrus followed by a gradual increase due to the presence of active CL reaching the peak on days 17-20 of the cycle (Figure 3).

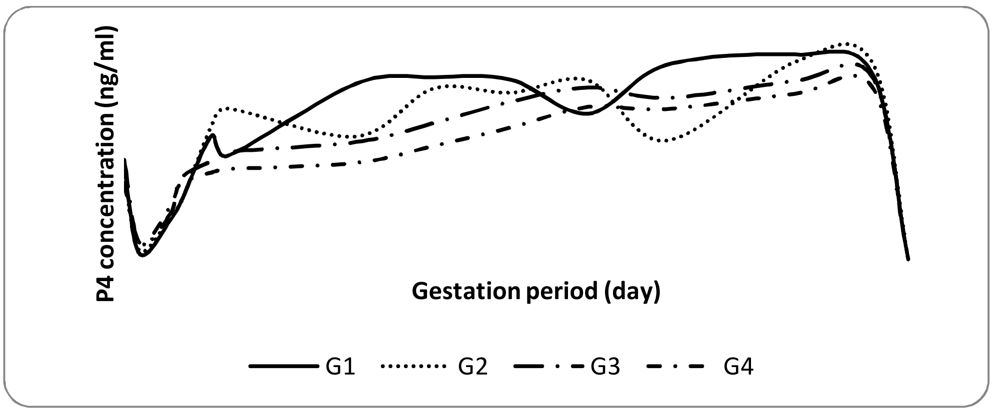


Fig. (3): Progesterone concentration (ng/ml) of different groups during gestation period.
G1; (Hay + fresh water), G2;(Hay + saline water), G3;(Salt tolerant plant + fresh water) , G4;(Salt tolerant plant + saline water).

On the other hand, during pregnancy, plasma E2 levels did not differ significantly among the four experimental groups and maintained unchanged till 148 days of gestation, then started to increase sharply till parturition (Figure 2). Hormonal profile during gestation period agreed with those reported by **Hamon and Heap (1990)** and **Henze *et al.* (1994)**.

Our results indicated that, for all tested goats, the diets contained salt-tolerant alfalfa did not affect the serum P4 concentration and pattern from mating to kidding, was normal and resembled the control ones. Similar results were reported by **Zarkawi *et al.* (2005)** who concluded that diet containing salt-tolerant *Sesbaniaaculeta* hay had no effect on the serum progesterone concentration from mating to lambing between different groups in Syrian Awassi ewes. Also, **Ali *et al.* (1991)** reported that the progesterone concentration and pattern were normal in Dwarf goats fed salt-tolerant Kallar grass hay in Pakistan. Similarly, **Digby *et al.* (2008)** reported that plasma P4 concentration was not different between the animals fed diet contain 0.5% NaCl (control group) and 13% NaCl (treated group). They found that P4 level prior to pregnancy was low (0.69 and 0.47 ng/ml for control and high salt group, respectively), before rising slowly to 2.6 ng/ml on day 79. P4 concentration then increased more rapidly, reaching 5.6 ng/ml on day 115 and 12.4 ng/ml on day 140, which support our results.

Conclusions

It could be concluded that utilization of salt-tolerant plants as animal feeds in salt affected lands could be an appropriate option for alleviating the desertification problems and providing alternative good feed resources particularly in summer and autumn seasons when the other conventional forage resources are shortage. Also, we can use saline water (6000 ppm TDS) as a source of drinking water without any adverse effects on reproductive and productive performance of Damascus goats.

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6/22/2013