Global Advanced Research Journal of Agricultural Science (ISSN: 2315-5094) Vol. 5(7) pp. 263-276, July, 2016 Issue.
Available online http://garj.org/garjas/home

Full Length Research Paper

Effect of Feeding Treatments on Productive and Reproductive Performance of She-Camels

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Accepted 08 June, 2016

Total of 27 She-camels at late pregnancy were allocated to 9 dietary treatments, including T1: 60% rice straw (RS), T2: 30% RS+30% berseem hay (BH), T3: 40% RS+20% BH, T4: 60% bagasse (BA), T5: 30% BA+30% BH, T6: 40% BA+20% BH, T7: 60% *Atriplex halimus* (AX), T8: 30% AX+30% BH and T9: 40% AX+20% BH. Concentration of total proteins (TP), albumin (AL), globulin (GL), glucose, progesterone (P4) and estrogen (E2), activity of alkaline phosphatase (ALP) in blood serum during pre- and 2 and 4-wk post-partum (PP), reproductive performance measurements including live body weight (LBW) at 1st service, service period (SP), number of services/conception (NSC), conception rate (CR), gestation period (GP) and placental characteristics at parturition of camels, and LBW of their offsprings were recorded. Results showed that T8 showed the highest concentration of TP and GL, the lowest AL concentration and AL/GL ratio in blood serum during pre-partum. T4 showed the highest serum glucose concentration only during pre-partum. T8 and T9 showed the least NSC, the shortest SP and the highest CR (P<0.05). T1 and T4 showed the poorest reproductive parameters (P<0.05). During pre-partum, T8 showed the highest P4 and the lowest E2 concentration in blood serum. It could be concluded that utilization of Atriplex at levels of 30 or 40% with berseem hay, as camel forage (60%) during the late pregnancy and post-partum period in Egypt, successfully improved productive and reproductive performance of She-camels and growth performance of their offsprings.

Keywords: Camel, forage, Atriplex halimus, milk, reproduction, productive, offspring.

INTRODUCTION

Maghrebian camels found in most coastal zones of the North African territories that extend from Egypt to Morocco. The Maghrebian is a camel of several strains that vary in size, body conformation and color. It is believed to be a mixture of the Sudani, Egyptian, Libyan and Tunisian camels (Wilson, 1984). The Maghrebian camel is medium in size with small but pointed hump. Besides pack use, the Maghrebian camel is used for all kinds of agricultural, industrial and draft purposes. A number of types are locally developed serve certain functions. The Maghrebian camel generally responds to feeding and might gain about 700-1000 g per day during the first year under intensive conditions (Wardeh, 2004).

Knowledge about the nutritional physiology of the camel is little, in particular, about their requirements for energy. Camels are more sensitive to energy than protein deficiency and supplementation and they can utilize poor quality roughages if forced to use exclusively on it (Lechner

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and Englehardt, 1989). The energy requirements increase by about 12% for lactating farm animals. Hence, the metabolizable energy for lactating She-camels to produces 5 kg milk daily was 487.4 KJ. It was assumed that the energy requirements of pregnant camels increase faster during the last third in a fashion similar to those of cattle and sheep. An extra 20% of the energy requirements for maintenance were added during the ninth and tenth months and 50% from the start of the eleventh month to delivery (Wardeh, 2004).

Camels are animals raised in the arid and semi-arid regions where fodder trees and shrubs predominate as the main feed resource (Von Kaufmann, 1986). Tree and shrub forages play an important role in ruminant feeding in arid and semi-arid regions of the northern region of Egypt (Salem *et al*., 2010). Halophyte shrubs of the genus Atriplex tend to predominate in these areas, mostly because of their resistance to drought which may be coupled with low or high ambient temperatures (Uchiyama, 1987). The leaves have a high content of sodium chloride and secondary metabolites (Valderrábano *et al*., 1996), including tannins, flavonoids, saponins, alkaloids and resins (Salem *et al*., 2006). These characteristics of *Atriplex halimus* tends to reduce fodder palatability and feed intake (Valderrábano *et al*., 1996) of sheep and goats. The protein fraction in A. halimus leaves also contains high levels of non-protein N (Le Houérou, 1992). Dried tree legume leaf-meal diets have improved performance of animals, which was attributed to improved utilization of endogenous N in the rumen and changes in the solubility of protein, and increased rumen escape dietary protein, as well as the amount and profile of amino acid absorbed post-ruminally from leaf meal (Rubanza *et al*., 2007).

Feed shortage is an important constraint to camel production in Egypt. In summer season, it is found between animal needs and the available animal feeds, addition, berseem (*Trifolium alexandrinum*) hay, which main good quality roughage feed in Egypt during summer months, it is available in limited amounts and is expensive prices (Mohamed *et al*., 2003). So, many attempts were carried out to solve this problem throughout using un-conventional sources of roughages to use it in rations formulation for different farm animals as alternative sources to depress the quantity of clover hay in ration formulation (Soha Abdel-Magid *et al*., 2015). The locally available saltbush can be a crucial source of perennial fodder to camels. There is limited information on the use of this fodder as a diet in camels (Safinaz Shawket *et al*., 2010).

The current study aimed to evaluate blood biochemical and reproductive performances of Maghrebian She-camels raised in Egypt as affected by feeding various levels and types of forages (60%) plus concentrate feed mixture (40%) during late pregnancy and post-partum period.

MATERIALS AND METHODS

This study was carried out at Center of Studies and Development of Camel Production, belonging to Animal Production Research Institute, Agricultural Research Center, Marsa Matrouh Governorate, Egypt.

Experimental animals:

Total of 27 pregnant Maghrebian She-camels at the last three months of pregnancy with average live body weight of 469.51±20.32 kg and within the 2-5 parity were divided according to LBW and parity to nine experimental groups, 3 animals in each. Animal were housed individually and fed one of the nine experimental diets and water was offered all day time.

Animals were manually milked twice/day after the calves were allowed to suckle colostrums from their dams for one week.

Dietary treatments

During the last 3 months of pregnancy and during post-partum period, animals in all treatments were fed basal diet including concentrate feed mixture (CFM) beside different types of forages. Four types of roughages were used in this study, including berseem hay (BH), rice straw (RS), *Atriplex halimus* (AT) and bagasse (BA). Nine experimental diets were formulated in term of 40% CFM and 60% forage as shown in Table 1.

The CFM used in feeding all the experimental animals was composed of 25% wheat bran, 25% yellow corn, 9% uncorticated cotton seed meal, 20% barely, 15% rice brain, 3% molasses, 2% premix and 1% common salt. Chemical analysis of CFM, BH, RS AX and BS and composition of the experimental diets are shown in Table 2.

Feeds were offered to animals in all groups twice daily for an experimental feeding period of 6 months (3 months pre- and 3 months post-partum).

Milking and milk samples

Milk yield was measured after the calves were allowed to suckle colostrums from their dams for the first seven days. Hand milking of the animals was done twice daily. After each milking, milk was weighed on limited day for each week for 30 weeks, and then monthly milk yield was calculated for 7 months lactation. Milk samples of each animal (mixture from morning and evening milking) were monthly taken for the determination of composition and physical characteristics of milk at the 1st, 2nd, 4th and 6th month of lactation period.

Table 1. Feeding system used in the experimental groups.

Treatment	CFM	Roughage type			
		BH	RS	BS	AX
T1	40%	-	60%	-	-
T2	40%	30%	30%	-	-
T3	40%	20%	40%	-	-
T4	40%	-	-	60%	-
T5	40%	30%	-	30%	-
T6	40%	20%	-	40%	-
T7	40%	-	-	-	60%
T8	40%	30%	-	-	30%
T9	40%	20%	-	-	40%

CFM: Concentrate feed mixture. BH: Berseem hay. RS: Rice straw. AX: Atriplex. BS: Bagasse.

Table 2. Chemical analysis (on DM basis) of concentrate feed mixture (CFM) and different types of roughages as well as formulation of the experimental diets used in feeding She-camels in all experimental groups.

Nutrient	CFM	Roughage type			
		BH	RS	BS	AX
DM (%)	89.44	89.0	88.46	57	34.78
Chemical analysis (%) on DM basis:					
OM	92.43	87.7	82.24	71.00	79.89
CF	8.85	30.5	35.69	45.09	10.40
CP	12.24	11.3	2.53	1.77	16.70
EE	4.64	3.20	1.52	0.80	1.60
NFE	66.70	37.7	40.50	50.23	51.19
Ash	7.57	12.3	19.76	2.11	20.11

CFM: Concentrate feed mixture. BH: Berseem hay. RS: Rice straw. AX: Atriplex. BS: Bagasse.

Blood parameters and sampling time

Animals in each experimental group were bled one week pre-partum and 2 and 4 weeks post-partum. Bleeding was done before morning feeding. During each bleeding time, blood was collected from each animal by jugular vein-puncture into clean test-tubes. The test-tubes and their contents were allowed to stand for about six hours, and the serum which had separated from cells was carefully decanted into serum vials. Serum samples were stored in deep freezer (–20◦ C) before being analyzed for total proteins, albumin, and glucose. Also, activity of alkaline phosphatase (ALP) and hormonal concentration of estradiol17-β (E2) and progesterone (P4) was determined in blood serum. However, concentration of globulin and AG/ratio were calculated.

Experimental procedures

Average LBW of camel calves produced from each group was recorded at birth and for 7 months post-calving.

Chemical analysis of CFM was determined after the official methods of AOAC (1980), while chemical analysis of milk was determined using Milko-Scan (Model 133 B).

All blood parameters were determined using chemical commercial kits and spectrophotometer, while hormonal assay was performed by RIA.

Statistical analysis

Statistical analyses of the data were carried out by completely random design (General Linear Model (GLM)

Table 3. Average live body weight of She-camels in different experimental groups during pre- and post-partum months.

Treat.	Initial	Pre-partum interval			Post-partum interval			
		3 Month	2 Month	1 Month	At parturition	1 Month	2 Month	3 Month
T1	457.9±19.82^{a}	472.3±19.61^{a}	488.0±19.94^{a}	508.3±18.46^{b}	471.5±19.04^{a}	484.0±18.94^{a}	498.1±18.80^{b}	513.2±19.20^{b}
T2	460.1±19.04^{a}	476.6±18.91^{a}	495.3±18.64^{a}	517.3±18.24^{ab}	478.0±18.72^{a}	492.8±18.73^{a}	510.5±18.88^{ab}	530.2±18.98^{ab}
T3	466.6±11.71^{a}	482.4±11.87^{a}	500.0±12.43^{a}	521.9±13.08^{ab}	484.2±13.12^{a}	497.9±13.25^{a}	514.2±13.18^{ab}	533.0±13.43^{ab}
T4	464.9±7.29^{a}	480.6±7.24^{a}	497.4±7.51^{a}	518.5±7.46^{ab}	479.2±7.72^{a}	493.0±7.55^{a}	509.8±7.51^{ab}	526.9±7.43^{ab}
T5	482.8±4.78^{a}	500.9±5.15^{a}	521.6±5.59^{a}	545.4±6.51^{ab}	505.7±6.92^{a}	522.8±7.04^{a}	540.9±7.11^{a}	560.1±6.51^{a}
T6	474.5±6.30^{a}	492.0±6.32^{a}	511.8±6.44^{a}	534.13±5.85^{ab}	494.60±6.10^{a}	510.35±5.83^{a}	528.10±5.79^{ab}	546.73±5.64^{ab}
T7	470.1±10.64^{a}	489.6±10.78^{a}	511.4±10.99^{a}	534.9±11.37^{ab}	495.0±10.89^{a}	512.9±11.18^{a}	531.8±11.49^{ab}	551.0±11.35^{ab}
T8	475.8±9.95^{a}	497.4±11.18^{a}	521.3±10.25^{a}	547.5±9.96^{ab}	504.2±11.12^{a}	524.0±11.23^{a}	544.3±11.05^{a}	567.2±11.11^{a}
T9	481.6±7.22^{a}	502.1±7.35^{a}	524.6±9.61^{a}	549.4±10.12^{a}	502.8±10.22^{a}	521.4±10.21^{a}	541.3±10.24^{a}	562.7±10.28^{a}

Means denoted within the same column with different superscripts are significantly different at P<0.05.

procedures; SAS, 1999, version 8.0) according to the following model: ***Yij = Ti + Eij***, where *Yij* = the overall mean, *Ti* = the fixed effect of Ith treatment and *Eij* = random error. Significant differences were determined by Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Change in live body weight of She-camels

Results shown in Table 3 revealed insignificant differences among different experimental groups in LBW of She-camels during 3, 2 and 1 month pre-partum. Also, LBW did not differ significantly among the experimental groups at parturition, or during the 1st and 2nd month post-partum. However, during the 3rd month post-partum, marked differences in LBW were observed among the experimental groups, whereas camels in T8 showed significantly (P<0.05) the heaviest weights (567.2 kg), but significantly (P<0.05) differed from those in T1 only. Such results indicated impact of feeding camel on D8 (30% AX + 30% BH as types of roughages on LBW of camels during post-partum period as compared to other diets.

Results also revealed gradual increase in LBW of camels during the late three pre-partum months in all groups up to incidence of parturition. This increase was associated with increasing size and weight of fetus during this period. At parturition, LBW of camels markedly reduced due to losing placenta and embryonic membranes as well as calf birth in all groups. During post-partum period, LBW of camels in all groups showed again gradual increase throughout the 1st three post-partum months.

In accordance with the present results, Abdel-Wahed (2014) found that average daily gain and relative weight changes were higher (P<0.05) in dromedary camels fed the hay and Atriplex, which decreases with limiting concentrate offered to 50% of ad lib intake.

As indicator for LBW, some investigators indicated that average daily gain of camels (ADG) was affected significantly (P<0.05) by the type of roughages. In this line, Kamoun *et al.* (1989) found that the ADG in one-year old camels was affected by feeding *ad libitum* hay plus concentrate. While, Etman (1997) found that the ADG was higher for camels fed berseem or hay plus concentrate than for those fed wheat straw plus concentrate. Moreover, data on ADG of the growing female dromedaries in response to changing the type of roughage (Farid *et al.*, 2010) indicated significantly higher ADG of camels fed on 50% CFM plus Atriplex or hay than of those fed rice straw. Generally, Abdel-Wahed (2014) concluded that camels grazing halophytes (e.g. Atriplex feeding) responded to supplementation in a way similar to their clover hay fed mates.

From the aforementioned results, *Atriplex nummularia* had a pronounced nutritive value as a fodder component when mixed with other plant species like berseem hay for camels. The main disadvantages of its using alone as animal feed are high ash and minerals contents and insufficient energy density (Afaf Fayed *et al.*, 2010). On the other hand, , Abdel-Wahed (2014) mentioned that camels fed high concentrate levels at 95% ad lib with clover hay

Table 4. Average monthly milk yield (kg) of She-camels in different treatments during seven months of lactation period.

Treat.	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month
T1	80.13±1.00^{g}	91.52±0.78^{f}	101.71±0.69^{g}	105.08±1.20^{d}	98.23±1.01^{e}	90.97±1.12^{e}	85.13±1.01^{f}
T2	85.09±0.55^{de}	95.81±0.81^{de}	109.38±1.10^{de}	113.33±0.85^{bc}	105.05±1.01^{cd}	96.39±1.16^{cd}	87.86±0.86^{df}
T3	82.65±0.48^{f}	94.13±0.81^{e}	107.33±1.03^{ef}	112.27±0.93^{bc}	104.00±0.80^{d}	94.87±1.11^{d}	86.94±0.84^{ef}
T4	83.64±0.44^{ef}	93.82±0.77^{ef}	106.65±0.83^{f}	111.33±0.92^{c}	103.57±0.85^{d}	94.74±1.03^{d}	86.65±0.64^{ef}
T5	87.07±0.39^{cd}	98.58±0.62^{bc}	112.25±0.78^{bc}	114.93±0.99^{b}	107.03±0.88^{c}	98.88±0.87^{c}	90.51±0.74^{c}
T6	85.83±0.68^{d}	96.80±0.98^{cd}	110.18±1.05^{cd}	112.95±1.01^{bc}	105.84±1.13^{cd}	97.34±1.01^{cd}	89.35±0.64^{cd}
T7	87.97±0.92^{bc}	100.06±0.87^{ab}	114.31±0.31^{ab}	118.37±0.96^{a}	111.18±0.71^{b}	103.54±0.75^{b}	96.13±0.72^{b}
T8	90.48±0.91^{a}	102.27±0.82^{a}	116.56±0.70^{a}	121.27±0.61^{a}	114.05±0.75^{a}	107.35±0.90^{a}	99.80±0.64^{a}
T9	89.51±0.74^{ab}	101.18±1.07^{a}	115.51±0.90^{a}	119.99±0.89^{a}	112.76±0.87^{ab}	105.94±1.09^{ab}	98.88±1.02^{a}

Means denoted within the same column with different superscripts are significantly different at P<0.05.

showed the best results concerning feed intake and digestibility, energy intake, nitrogen balance, body weight gain and feed efficiency, while those fed Atriplex had the highest feed intake. Also, Riaz *et al*. (1994) reported significant (P<0.01) decrease in weight gain and feed intake with increasing level of Atriplex in Teddy goats offered 100% *Atriplex amnicola* diets.

Milk yield production of She-camels

Average monthly milk yield

Results presented in Table 4 showed significant differences in monthly milk yield among the experimental groups throughout a lactation period of 7 months. She-camels fed D8 (T8) showed significantly (P<0.05) the highest milk production, followed by those fed D9 (T9) in term of monthly milk yield during a lactation period of 7 months, while camels fed D1 (T1) showed significantly (P<0.05) the lowest milk production. Generally, the present values of milk yield in all groups are within a range from 3.5-4.5 kg/day in Egypt as reported by El-Bahey (1962).

When milk production was expressed in term of average daily milk yield for 30 lactation weeks, average daily milk yield in all experimental groups showed the same trend of change during the lactation weeks and even the same differences among the experimental groups in milk yield. Average daily milk yield gradually increased after parturition up to the 14 week, showing peak of lactation in all groups, and then it gradually decreased up to 30 weeks of lactation. She-camel in T8 showed the highest milk yield versus the lowest milk yield in T1 (Figure 1). In camel, the lactation curve differs from that of cows (Al-Sheikh and Salah, 1994) and camels may have one or two peaks to reach their milk peak during the first 6 and 10 weeks after parturition (Chamberlain, 1989). Lactation curve with two peaks at the 5th and 7th month of calving was reported in camels fed Atriplex, while the lactation curve of camels fed berseem hay has one peak at the 4th month of calving (Safinaz Shawket and Ibrahem, 2010). Musaad *et al.* (2013) reported that overall mean values were milk yield up to 12 months, 1,970±790 l; lactation length, 12.5 months; persistency, 94.7 %; weekly peak yield, 50.7 l; monthly peak yield, 220±90 l; and the number of weeks to reach peak yield, 28. The highest productivity was recorded in summer with a weekly mean of 48.2±19.4 l, compared with 34.1±16.3 l in winter.

Generally, enhancing milk yield in high genetic merit animals or high yielders is associated with effectiveness of dietary energy supplements (Gihad *et al*., 1987). It has been suggested that the maximum milk production is not achieved until cows are in a positive energy balance (Davison *et al*., 1991). According to the previous findings, the present results indicated one milk peak 12 weeks after calving in all experimental groups fed different roughage types (Figure 1).

These findings indicated that camels in all groups had negative energy balance during early post-partum period till 12 weeks of parturition. Therefore, the difference in camel milk peak timing may reflect energy balance affecting milk production and may be due to variation in nutritional state of camels (Landete -Castillajos *et al*., 2002).

In addition, the obtained results may indicate impact of feeding She-camels during pre- and post-partum periods on diet containing 40% CFM plus 30 or 40% Atriplex (T8 and T9) on milk yield during the lactation period, while camels fed 40% CFM plus 60% rice straw (T1) adversely affected milk yield. In agreement with the highest increase in milk yield significantly (P<0.05) in camels fed diet containing T8 and T9, Safinaz Shawket and Ibrahim (2010) found that inclusion fresh Atriplex (saltbush) instead of berseem hay in the diet of camels increased (P<0.05) the milk production (4.00 vs. 3.31 kg/day/camel). However,

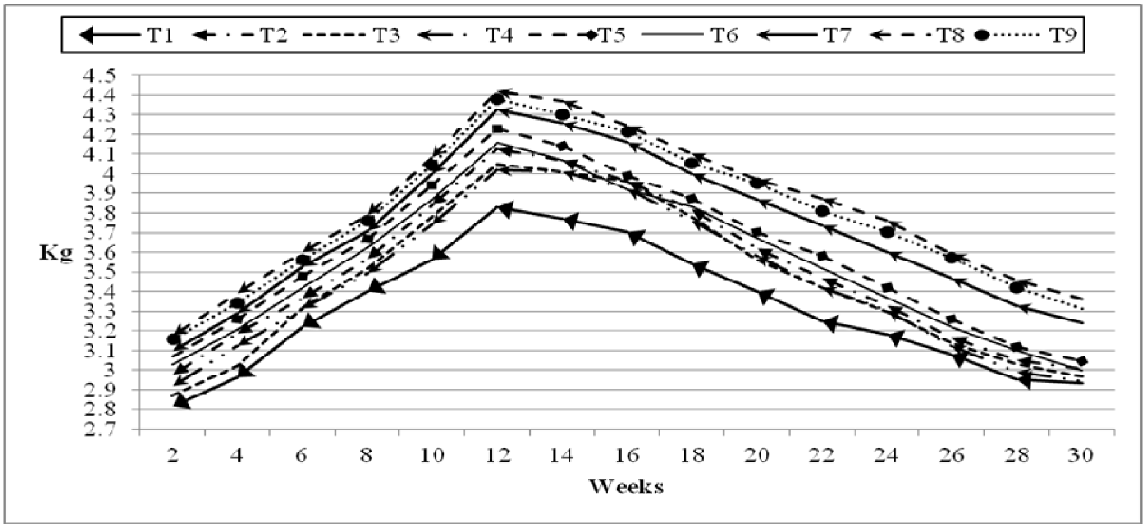

Figure 1. Change in daily milk yield of She-camel in different experimental groups during lactation weeks.

Abu-Zanat and Tabbaa (2006) found insignificant effect of the proportion of saltbush foliage diets containing 0, 50 and 100% on milk production.

Milk composition

Results presented in Table 5 revealed marked increase in milk contents including fat, protein and lactose, but this effect was significant (P<0.05) on fat content at the 1st and 6th months and protein content at the 1st and 2nd months. However, lactose content was not affected by the experimental diets.

The present values of camel milk components in this study are within the normal range of fat, protein and lactose, being 3.5-5.5, 2.8-4.5 and 3.4-4.6% as reported by Mehaia (1994), respectively. In addition, Khan and Iqbal (2001) reported that chemical composition of camel milk is in the range of: 2.9-5.5% fat, 2.5-4.5% total protein and 2.9-5.8% lactose. The wide variation in chemical composition of camel milk may be due to factors such as stage of lactation, age, number of calving, nutritional state and water intake (Chamberlain, 1989).

It is worthy noting that the recorded significantly higher milk yield of camels in T8 was associated with an increase in milk contents, in particular, fat and protein contents, although Faye *et al*. (2008) recorded a negative correlation between milk yield and fat percentage in camels. However, Al-Dobaib (2009) reported no changes in milk fat percentage as the milk yield was not increased, which is attributed to the dilution factor. Such trend may lead to increasing yield of fat and protein, either for calf suckling or human consumption.

It is of interest to note that She-camels in T8 or T9 fed 30 or 40% Atriplex, respectively, maintained fat percentage above 4% during all lactation months studied as compared to other groups (Table 5). Al-Saiady *et al*. (2012) reported that dietary energy levels affect only fat and ash percentages in camel milk, which is associated with differences in milk contents (fat and protein) in experimental groups fed different roughage types

Results also showed that milk of camels fed Atriplex contained highest (P<0.05) protein level due to the higher crude protein (%) content of Atriplex than other types of roughages (Table 2) which confirmed the early conclusion that the feed protein content will directly affect milk protein content (Wilson, 1984). Also, Shetaewi (2001) reported that feeding BH resulted in more than two fold increase in milk production compared with feeding RS. However, Abdalla *et al*. (2013) found that total solids, fat and protein percentages in goat milk were not affected by type of roughages, whereas lactose percentages significantly differed (P≤0.05) in BH group compared to alfalfa group.

Numerous studies have shown that the average rate of lactose can vary between 29 and 58g/l (Khaskheli *et al*., 2005). The obtained results are within this range with a small variation between samples as affected by the experimental diet. Therefore, the insignificant effect of the experimental diets on lactose content in camel milk could be due to similar type of vegetation eaten (Khaskheli *et al*., 2005).

Table 5. Contents (%) of fat, protein and lactose in milk of She-camel in different treatments during lactation months.

Treatment	1st Month	2nd Month	4th Month	6th Month
Fat (%):				
T1	4.06±0.10c	4.00±0.09 a	3.93±0.12 a	3.44±0.08d
T2	4.43±0.16abc	4.23±0.20 a	4.11±0.17 a	3.83±0.16bcd
T3	4.18±0.22c	4.13±0.18 a	3.77±0.16 a	3.64±0.09cd
T4	4.31±0.15bc	4.13±0.19 a	3.93±0.17 a	3.73±0.09bcd
T5	4.47±0.16abc	4.27±0.19 a	4.27±0.18 a	3.98±0.16abc
T6	4.35±0.18bc	4.22±0.18 a	4.10±0.17 a	3.85±0.12bc
T7	4.48±0.16abc	4.16±0.22 a	4.10±0.19 a	4.00±0.12abc
T8	4.86±0.04a	4.37±0.13 a	4.30±0.18 a	4.30±0.17a
T9	4.73±0.11ab	4.26±0.18 a	4.11±0.18 a	4.11±0.10ab
Protein (%):				
T1	4.47±0.19abc	3.65±0.08b	3.55±0.08 a	3.49±0.07 a
T2	4.57±0.17abc	3.84±0.13 ab	3.72±0.14 a	3.66±0.15 a
T3	4.16±0.21cd	3.77±0.17 ab	3.68±0.17 a	3.55±0.11 a
T4	4.50±0.16abc	3.73±0.14 ab	3.69±0.17 a	3.59±0.12 a
T5	3.71±0.15 d	3.86±0.13 ab	3.77±0.17 a	3.69±0.17 a
T6	4.20±0.21bc	3.81±0.17 a	3.68±0.17 a	3.65±0.17 bc
T7	4.60±0.15abc	4.02±0.20 ab	3.77±0.17 a	3.69±0.17 a
T8	4.82±0.10 a	4.19±0.17 a	3.96±0.18 a	3.89±0.14 a
T9	4.70±0.09ab	4.11±0.20 ab	3.85±0.16 a	3.80±0.17 a
Lactose (%):				
T1	4.55±0.18 a	4.59±0.13 a	4.64±0.07 a	4.69±0.06 a
T2	4.67±0.15 a	4.71±0.15 a	4.76±0.04 a	4.80±0.11 a
T3	4.63±0.15 a	4.68±0.06 a	4.73±0.15 a	4.77±0.14 a
T4	4.65±0.07 a	4.67±0.06 a	4.72±0.15 a	4.76±0.14 a
T5	4.73±0.15 a	4.78±0.15 a	4.81±0.13 a	4.86±0.20 a
T6	4.68±0.06 a	4.72±0.04 a	4.77±0.14 a	4.80±0.11 a
T7	4.71±0.04 a	4.77±0.14 a	4.82±0.13 a	4.88±0.20 a
T8	4.77±0.04 a	4.82±0.11 a	4.88±0.17 a	4.94±0.21 a
T9	4.74±0.04 a	4.78±0.03 a	4.84±0.03 a	4.90±0.09 a

Means denoted within the same column with different superscripts are significantly different at P<0.05.

Live body weight of camel calves:

Data presented in Table 6 show significant (P<0.05) differences in LBW of camel calves produced from different experimental groups for 7 months after birth. From birth up to 7 months of age, LBW of camel calves was significantly (P<0.05) the highest in T8 and the lowest in T1 as compared to other treatment groups. These findings indicated that the nutritional status of She-camels in late pregnancy affects birth weight of camel calves, and also in post-partum affects LBW up to the 7th month of age. This means that feeding She-camels pre- and post-partum period on 30% Ax and 30% BH beside 40% CFM in this study was more adequate to meet the requirement of nutrients. In similarly, feeding additional fats in iso-energetic diets during late pregnancy improved lamb birth weight (Ghoreishi *et al*., 2007).

Blood parameters

Concentration of total proteins and their fractions

Data in Table 7 showed that effect of the experimental diets on concentration of total proteins (TP), albumin (ALB) and globulin (GLOB), or ALB/ GLOB ratio in blood serum of camels was significant (P<0.05) only during pre-partum period. However, this effect was insignificant during the 1st two and four weeks of post-partum period.

During pre-partum period, camels in T8 showed significantly (P<0.05) the highest TP and GLOB

Table 6. Average live body weight of calves of She-camel in different experimental groups from birth up to 7 months of age.

Treat.	At birth	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month
T1	25.8±0.18^{b}	36.5±0.86^{g}	48.6±0.82^{e}	62.6±0.42^{e}	75.9±1.74^{e}	88.6±1.63^{e}	100.3±1.1^{g}	114.1±0.35^{h}
T2	27.9±1.08^{ab}	39.9±0.95^{ef}	51.1±1.03^{de}	64.5±1.10^{de}	78.6±0.80^{d}	91.9±0.81^{d}	104.3±0.62^{ef}	119.4±0.26^{f}
T3	26.4±0.86^{b}	38.6±0.78^{f}	49.4±0.56^{e}	63.1±1.03^{e}	76.3±0.16^{e}	89.1±0.23^{e}	103.3±0.56^{f}	117.9±0.23^{g}
T4	27.6±0.94^{ab}	41.3±0.90^{de}	53.6±0.46^{cd}	66.13±0.40^{cd}	78.4±0.26^{d}	91.1±0.58^{d}	105.3±0.17^{de}	120.6±0.98^{e}
T5	28.2±0.22^{ab}	42.4±0.82^{bcd}	58.3±2.03^{ab}	70.2±1.61^{b}	80.6±0.85^{d}	93.1±0.45^{d}	106.7±0.50^{d}	122.8±0.36^{d}
T6	27.9±0.72^{ab}	41.8±0.82^{cde}	55.9±0.67^{bc}	67.9±0.23^{c}	79.1±0.13^{d}	92.1±0.55^{d}	106.6±0.18^{d}	121.9±0.23^{d}
T7	28.1±1.04^{ab}	43.8±0.37^{abc}	57.9±0.30^{ab}	71.4±0.32^{b}	83.1±0.64^{c}	96.4±0.18^{c}	111.1±0.30^{c}	126.5±0.33^{c}
T8	30.8±1.71^{a}	45.4±0.42^{a}	60.8±0.41^{a}	74.8±0.45^{a}	88.4±0.26^{a}	102.4±0.18^{a}	116.8±0.25^{a}	131.6±0.26^{a}
T9	30.1±1.51^{a}	44.6±0.42^{ab}	58.5±0.19^{ab}	72.3±0.25^{b}	86.1±0.23^{b}	99.8±0.49^{b}	113.3±0.45^{b}	128.8±0.25^{b}

Means denoted within the same column with different superscripts are significantly different at $P<0.05$.

Table 7. Concentration of total proteins and their fractions in blood serum of She-camels in different treatments during pre- and post-partum periods.

Treatment	Total proteins (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G ratio
Pre-partum:				
T1	6.93±0.16^{d}	4.10±0.13^{a}	2.83±0.23^{f}	1.55±0.18^{a}
T2	7.42±0.11^{bc}	3.84±0.09^{abc}	3.58±0.15^{cde}	1.09±0.06^{bc}
T3	7.16±0.17^{cd}	3.93±0.19^{ab}	3.23±0.27^{ef}	1.32±0.20^{ab}
T4	7.14±0.05^{cd}	3.68±0.09^{bcd}	3.46±0.11^{de}	1.07±0.06^{bc}
T5	7.71±0.21^{ab}	3.47±0.16^{cd}	4.24±0.28^{ab}	0.87±0.12^{cd}
T6	7.53±0.09^{bc}	3.59±0.13^{bcd}	3.94±0.14^{bcd}	0.93±0.06^{cd}
T7	7.55±0.14^{bc}	3.41±0.08^{d}	4.14±0.18^{bc}	0.84±0.06^{cd}
T8	8.10±0.11^{a}	3.36±0.13^{d}	4.74±0.12^{a}	0.72±0.04^{d}
T9	7.72±0.13^{ab}	3.40±0.16^{d}	4.32±0.21^{ab}	0.81±0.08^{cd}
Two weeks post-partum:				
T1	7.29±0.23^{a}	3.73±0.14^{a}	3.56±0.27^{a}	1.04±0.13^{a}
T2	7.40±0.20^{a}	3.60±0.17^{a}	3.80±0.31^{a}	1.01±0.13^{a}
T3	7.44±0.11^{a}	3.70±0.13^{a}	3.74±0.19^{a}	1.01±0.08^{a}
T4	7.70±0.27^{a}	3.96±0.17^{a}	3.74±0.21^{a}	1.06±0.06^{a}
T5	7.40±0.28^{a}	3.66±0.09^{a}	3.74±0.27^{a}	1.02±0.08^{a}
T6	7.23±0.11^{a}	3.53±0.10^{a}	3.70±0.14^{a}	0.97±0.06^{a}
T7	7.22±0.27^{a}	3.65±0.15^{a}	3.57±0.23^{a}	1.06±0.09^{a}
T8	7.48±0.15^{a}	3.67±0.08^{a}	3.81±0.25^{a}	1.02±0.11^{a}
T9	7.57±0.21^{a}	3.93±0.14^{a}	3.64±0.31^{a}	1.14±0.11^{a}
Four weeks post-partum:				
T1	7.51±0.11^{a}	3.84±0.15^{a}	3.66±0.23^{a}	1.11±0.13^{a}
T2	7.38±0.16^{a}	3.92±0.20^{a}	3.47±0.26^{a}	1.19±0.13^{a}
T3	7.61±0.29^{a}	3.68±0.10^{a}	3.93±0.34^{a}	1.02±0.15^{a}
T4	7.68±0.16^{a}	3.56±0.11^{a}	4.13±0.14^{a}	0.87±0.04^{a}
T5	7.67±0.21^{a}	3.56±0.14^{a}	4.12±0.27^{a}	0.89±0.07^{a}
T6	7.67±0.20^{a}	3.48±0.14^{a}	4.19±0.13^{a}	0.84±0.04^{a}
T7	7.30±0.12^{a}	3.86±0.21^{a}	3.44±0.24^{a}	1.19±0.16^{a}
T8	7.09±0.25^{a}	3.64±0.19^{a}	3.45±0.29^{a}	1.13±0.14^{a}
T9	7.35±0.11^{a}	3.58±0.21^{a}	3.78±0.27^{a}	1.02±0.15^{a}

Means denoted within the same column with different superscripts are significantly different at $P<0.05$.

concentrations and the lowest ALB and ALB/GLOB ratio, while those in T1 showed an opposite trend in blood serum. It is of interest to note that increasing TP concentration and decreasing ALB/GLOB ratio in serum of camels in T8 was associated with significant (P<0.05) increase in ALB and decrease in GLOB concentrations as affected by feeding 30% AX diet. The observed increase in TP concentration may be attributed to increasing CP content in Atriplex as compared to other forage types used in this study (Table 2) as reported by Afaf Fayed *et al*. (2010).

In accordance with the effect of dietary treatments on protein metabolism in camels, Soha Abdel-Magid *et al*. (2015) found that substitution clover hay by onion haulms at different levels significantly (P<0.05) increased concentration of TP and GLOB, decreased ALB/GLOB ratio, but did not affect ALB in growing camels.

Results in Table 7 also revealed insignificant effect of the experimental diets on protein metabolism during the 1st two and four week post-partum, and this may be in relation with the negative energy balance during the early post-partum period. Generally, concentration of TP and their fractions showed slight differences during pre- and post-partum periods and the present values of TP, ALB, GLOB and ALB/GLOB ratio are within the normal range reported by (Mostafa *et al*., 2013). Also, values of albumin are within the normal range for camels in good conditions (Amin *et al*., 2007). However, Al-Zamely (2011) found significant decrease (P<0.05) in TP concentration in pregnant in comparison with non-pregnant animals. This decrease may be due to transport of amino acids and protein to the placenta or as affected by elevating progesterone level during pregnancy, which may affect liver and cause decreasing ALB production (Pineda and Dooley, 2003).

Carbohydrate metabolism and enzyme activity

Regarding the serum glucose concentration as an indicator of carbohydrate metabolism (Table 8), camels in T4 showed significantly (P<0.05) the highest glucose values, while those in T1 showed significantly (P<0.05) the lowest values during pre-partum period. However, the effect of treatments on serum glucose concentration during 2 and 4 weeks post-partum was not significant. Treatments also, treatments showed significant (P<0.05) effect on activity of ALP in blood serum during pre-partum and post-partum (2 and 4 weeks) periods, being the highest in T8 and T9 and the lowest in T1.

It is of interest to note that glucose concentration and ALP activity showed slight differences pre-partum compared with post-partum period and even during 2 weeks compared with 4 weeks post-partum period (Table 8). Such results indicated pronounced effect of type and level of roughage in diet of camels on carbohydrate metabolism and activity of ALP in blood serum, particularly during pre-partum period. Inclusion of 60% BS (T4) in camel diet during the late pregnancy significantly (P<0.05) increased serum glucose concentration, meanwhile reversible situation had occurred when camels were fed 60, 30 or 40% RS (T1, T2 and T3, respectively). This may be attributed to increasing content of soluble carbohydrates and the lowest ash content in BS as compared to other types of roughages. Also, increasing CF in BS may increase volatile fatty acids (VFAs) concentration produced from the ruminal fermentation in T4. It is well known that VFAs are the main source of energy, while glucose is considered as a secondary source of energy in ruminant and in camels. Glucose estimates in our study are nearly similar to those previously reported by Al-Sultan (2003) on Mayhem breed of camels in Saudi Arabia (58 mg/dl). However, Faye and Mulato (1991) reported a normal range (50 to 120 mg/100 ml) for adult camels. As affected by feeding system, Al-Saiady *et al*. (2013) found that blood glucose level decreased when growing camels were fed on 13% CP with high energy level diet as compared to 12.4% CP with low energy diet due to using more glucose as an energy source, to increase body weight.

The observed increase (P<0.05) in glucose level during pregnancy (pre-partum period) in T4 might reflect the hyper metabolic state that animal suffered during pregnancy stress and the higher need for glucose, the output of adreno-corticotrophic hormone, glucocorticoids and adrenaline, is increased for breakdown of liver glycogen (Bell *et al*., 1961). In this way, Hill *et al*. (1984) reported that the concentration of adrenal corticoids rises during pregnancy and act especially in mobilizing amino acids from body protein, which is associated with an increased rate of hepatic deamination and conversion of certain of the resultant keto acids to glucose (Allen, 1977).

The importance of ALP enzyme come from its role in food absorption which aid in growth and development of fetus, in addition to liver and skeletal muscles which consider source of this enzyme (Shane and Suzuki, 1974). The present activity of ALP in this study ranged from 69 to 82 IU/l during pre- and post-partum periods, but ALP activity tended to be higher in pre- than in post-partum period. This trend is in accordance with results of Al-Zamely (2011), who found insignificant increase in ALP activity in pre- than in post-partum period in camels. Generally, this increase may be due to increase its production from placenta during pregnancy (Pirani *et al*., 1972).

Reproductive performance

Reproductive measurements

Data presented in Table 9 revealed that reproductive performance, in terms of live body weight (LBW) at 1st service (LBW), number of services per conception (NSC)

Table 8. Concentration of glucose and alkaline phosphatase (ALP) activity in blood serum of She-camels in different treatment during pre- and post-partum periods.

Treatment	Glucose (mg/dl)	ALP (IU/l)
Pre-partum period:		
T1	45.34±1.05^{c}	76.41±1.77^{c}
T2	48.21±0.49^{c}	77.12±0.77^{c}
T3	47.17±1.83^{c}	78.20±0.82^{bc}
T4	58.32±0.54^{a}	79.93±0.80^{ab}
T5	55.55±1.05^{ab}	80.83±0.68^{a}
T6	53.20±1.48^{b}	80.92±0.74^{a}
T7	54.7±2.08^{ab}	81.81±0.61^{a}
T8	56.34±2.35^{ab}	82.20±0.47^{a}
T9	54.99±1.80^{ab}	81.33±0.27^{a}
Two weeks post-partum period:		
T1	57.36±3.67^{a}	69.26±1.75^{b}
T2	52.25±2.74^{a}	70.82±0.48^{ab}
T3	50.46±2.60^{a}	70.80±0.53^{ab}
T4	51.89±3.19^{a}	70.62±0.88^{ab}
T5	55.61±2.66^{a}	71.14±0.44^{ab}
T6	48.58±3.02^{a}	70.88±0.69^{ab}
T7	54.72±2.27^{a}	71.51±0.42^{ab}
T8	52.78±2.34^{a}	72.51±1.03^{a}
T9	51.67±2.25^{a}	72.13±0.70^{a}
Four weeks post-partum:		
T1	55.78±2.34^{a}	71.07±0.37^{e}
T2	54.10±3.26^{a}	73.32±0.26^{bcd}
T3	53.67±2.53^{a}	72.45±0.40^{d}
T4	53.80±3.09^{a}	72.95±0.39^{cd}
T5	55.91±2.78^{a}	73.95±0.25^{bc}
T6	53.46±4.04^{a}	73.45±0.46^{bcd}
T7	50.42±2.93^{a}	74.07±0.32^{b}
T8	52.78±2.34^{a}	75.82±0.23^{a}
T9	51.67±2.26^{a}	75.20±0.16^{a}

Means denoted within the same column with different superscripts are significantly different at P<0.05.

and service period length (SPL), during post-partum period were affected significantly (P<0.05) by dietary treatment. At 1st service, camels were significantly (P<0.05) the heaviest in T3 versus the lightest weights in T5. It is of interest to note that camels in T8 and T9 significantly (P<0.05) showed the least NSC, shortest SPL and highest conception rates (CR) as compared to other treatment groups. On the other hand, camels in T1 and T4 showed significantly (P<0.05) the poorest reproductive parameters.

It is worthy noting that LBW at 1st service had no relation with reproductive parameters and this was due to appropriate LBW at 1st service in all treatment groups, ranging from 460.5 to 527.5 kg. However, there was an association in NSC, SPL and CR, being more pronounced in T1, whereas camels in this group showed the highest NSC and the longest SPL with the lowest CR (Table 9).

These findings indicated that feeding diet containing 60% RS and 40% CFM had adversely effects on reproductive performance of camels during post-partum period. However, inclusion of AX at level of 30 or 40% with 30 or 20% BH had impact on reproductive performance of camels.

Unfortunately, there was no information in the literature on the effect of type of roughages on reproductive performance of She-camels.

Table 9. Reproduction measurements of She-camel in different treatments during post-partum period.

Treatment	LBW at 1st service (kg)	No. of services per conception	Service period length (day)	Conception rate (%)
T1	470.6±12.80^{b}	3.38±0.26^{a}	18.75±0.59^{a}	33.3
T2	467.3±9.13^{b}	2.88±0.23^{abc}	16.88±0.58^{b}	66.6
T3	527.5±24.71^{a}	3.13±0.13^{ab}	16.38±0.53^{b}	66.6
T4	471.3±10.48^{b}	2.88±0.30^{abc}	16.63±0.78^{b}	33.3
T5	460.4±10.41^{b}	2.63±0.18^{abc}	15.88±0.79^{b}	66.6
T6	491.4±15.30^{ab}	2.75±0.16^{abc}	16.13±0.83^{b}	66.6
T7	522.2±21.99^{a}	2.38±0.18^{bc}	15.75±0.31^{b}	66.6
T8	463.3±13.31^{b}	2.25±0.41^{c}	14.88±0.44^{b}	100
T9	472.0±16.60^{b}	2.38±0.18^{bc}	15.13±0.51^{b}	100

Means denoted within the same column with different superscripts are significantly different at P<0.05.

Table 10. Gestation period and placental characteristics at parturition of She-camel in different treatments.

Treatment	Gestation period (day)	Placental drop (min)	Placental weight with fluids (kg)	Placenta weight without fluids (kg)
T1	380.6±0.84^{a}	178.75±2.80^{a}	11.01±0.23^{c}	3.63±0.07^{a}
T2	381.8±1.43^{a}	164.38±2.74^{c}	11.36±0.17^{bc}	3.76±0.12^{a}
T3	383.1±1.46^{a}	170.63±2.58^{bc}	11.26±0.13^{bc}	3.68±0.12^{a}
T4	380.1±0.61^{a}	175.88±1.53^{ab}	11.67±0.15^{ab}	3.78±0.12^{a}
T5	383.2±0.88^{a}	169.13±3.15^{bc}	11.70±0.17^{ab}	3.88±0.12^{a}
T6	382.2±1.70^{a}	170.38±3.05^{bc}	11.65±0.12^{ab}	3.79±0.12^{a}
T7	383.7±1.46^{a}	166.63±2.50^{c}	11.71±0.14^{ab}	3.81±0.14^{a}
T8	383.1±1.75^{a}	162.75±1.59^{c}	12.13±0.15^{a}	4.01±0.18^{a}
T9	384.3±1.15^{a}	164.13±1.72^{c}	11.96±0.20^{a}	3.94±0.17^{a}

Means denoted within the same column with different superscripts are significantly different at P<0.05.

Gestation period and placental characteristics

As affected by the experimental treatments, there were no differences in gestation period length of camels, however, dietary treatments showed significant (P<0.05) effect on placental characteristics, in terms of significantly (P<0.05) the shortest duration drop and the heaviest weights of placenta with fluids in T8 and T9, while placental weight without fluids was not affected significantly by dietary treatment (Table 10).

The present gestation periods in all treatments are within the normal rang reported by Wardeh (2004), who stated that pregnancy lasts from 12 to 13 months in the dromedary camel. It is of interest to note that the observed impairment in reproductive performance of camels in T1 may be related to the longest duration of placental drop and the highest weight of embryonic fluids, which play an important role in fetus protection during pregnancy (Hafez and Hafez, 2000).

Hormonal profile:

Results shown in Table 11 revealed significant (P<0.05) effect of treatments on concentration of progesterone (P4) during pre-partum and 4 wk post-partum and on estradiol17-β (E2) only during 4 wk post-partum periods. During pre-partum, concentration of P4 was significantly (P<0.05) the highest and concentration of E2 was insignificantly the lowest in blood serum of camels in T8, although P4 concentrations were almost more than 1 ng/ml in all treatments.

Level of P4 in females is a very useful tool to monitor pregnancy in camels. All camelids depend entirely on P4 from the CL to maintain their pregnancy (Skidmore, 2005).

Table 11. Concentration of reproductive hormones (progesterone and estradiol17-*β* in blood serum of She-camels in different experimental groups during pre-partum period.

Treatment	Progesterone (ng/ml)	Estradiol17-*β* (pg/ml)
Pre-partum period:		
T1	4.31±0.01^{f}	39.83±1.02^{a}
T2	4.59±0.36^{ef}	38.35±0.91^{a}
T3	4.47±0.35^{ef}	39.59±0.58^{a}
T4	4.84±0.19^{def}	39.33±0.81^{a}
T5	5.28±0.17^{cd}	38.23±0.85^{a}
T6	5.09±0.16^{de}	39.84±0.57^{a}
T7	5.80±0.15^{bc}	38.10±0.79^{a}
T8	6.55±0.14^{a}	37.98±0.75^{a}
T9	6.01±0.17^{ab}	38.18±0.67^{a}
Two weeks post-partum period:		
T1	1.31±0.01^{a}	76.08±1.13^{a}
T2	1.45±0.12^{a}	77.26±2.61^{a}
T3	1.40±0.12^{a}	76.88±2.88^{a}
T4	1.43±0.12^{a}	78.00±1.92^{a}
T5	1.45±0.11^{a}	79.26±1.54^{a}
T6	1.43±0.11^{a}	78.38±0.47^{a}
T7	1.51±0.15^{a}	79.13±0.62^{a}
T8	1.68±0.13^{a}	80.38±0.64^{a}
T9	1.60±0.12^{a}	80.12±0.80^{a}
Four weeks post-partum blood components:		
T1	2.31±0.02^{e}	81.33±0.39^{e}
T2	2.52±0.13^{e}	82.08±0.19^{de}
T3	2.34±0.01^{e}	81.83±0.28^{de}
T4	2.86±0.04^{d}	82.46±0.23^{cd}
T5	3.11±0.14^{cd}	83.08±0.21^{bc}
T6	2.99±0.12^{d}	82.64±0.19^{cd}
T7	3.36±0.18^{bc}	83.83±0.30^{ab}
T8	3.86±0.04^{a}	84.33±0.28^{a}
T9	3.61±0.18^{ab}	84.03±0.30^{a}

Means denoted within the same column with different superscripts are significantly different at P<0.05.

The present results regard to P4 concentration are in relation with incidence of pregnancy in all camels within each treatment during pre-partum, whereas increasing P4 level during above 1 ηg/ml was reported in pregnant female camels by Agarwal *et al*. (1992).

The rapid decrease in serum E2 observed during pre-partum might be attributed to the inhibitory influence of the rapidly rising plasma P4 (Jain, 1992). However, during post-partum period, there were insignificant differences in concentration of P4 and E2 at 2 weeks post-partum, but there were tendency of increase with significant (P<0.05) differences in these hormones at 4 weeks post-partum, being, the highest in T8 and T9 and the lowest in T1. These results may indicate the highest ovarian activity (cyclicity) in camels of T8 T9 as compared to other treatments. Increasing level of P4 and E2 in all treatments at 4 weeks post-partum also indicated early resumption of ovarian activity in all treatments, particularly in T8 and T9 (Table 11) .

Pre- and post-partum periods, the hormonal values in each group varied according to the reproductive status. In all groups, concentration of P4 and E2 was higher pre- than post-partum period. The obtained results indicated marked drop in P4 level and increase in E2 level at 2 wk post-partum as compared to pre-partum period due to regression of CLs post-parturition and ovarian follicle development. However, marked increase was observed in

P4 and E2 levels at 4 wk as compared to 2 wk post-partum due to resumption of ovarian activity at 4 wk post-partum.

CONCLUSION

It could be concluded that utilization of Atriplex at levels of 30 or 40% with berseem hay as camel forage (60%) during the late pregnancy and post-partum period in Egypt could be an appropriate option for alleviating the desertification problems and providing partially alternative good feed forage when the other conventional forage resources are shortage. This system of nutrition successfully improved milk yield and composition, reproductive performance of She-camels and growth performance of their offsprings.

ACKNOWLEDGMENT

Deep appreciation for all members of Center of Studies and Development of Camel Production, belonging to Animal Production Research Institute, Agricultural Research Center, Marsa Matrouh Governorate, Egypt.

This work was supported and funded by Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture, Egypt.

The authors declare that they have no conflict of interest

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