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EFFECT OF SOME NUTRITIONAL TREATMENTS ON PRODUCTIVE PERFORMANCE OF SHE-CAMELS

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ABSTRACT

Aim of this study was to determine the effect of supplementation of calcium salts of fatty acids (CSFA) from palm oil (PO) at two levels (3 and 6%) to the concentrate feed mixture (CFM) on productive performance of dromedary she-camels and weights of their calves. Nine she-camels were allocated to 3 groups fed the same basal diet consisted of CFM, berseem hay (BH) and rice straw (RS), but differed in PO level (0, 3, and 6%) representing G1, G2 and G3, respectively. The feeding period lasted from 3 months pre-natal and 3 months post-natal. Live body weight (LBW), yield and composition of milk of she-camels as well as birth weight of calves were recorded during pre, at and post-natal periods. Blood was collected pre, at and post-natal periods to determine protein and lipid metabolites and concentration of transaminases (AST and ALT) and hormones (Progesterone, P4 and estradiol, E2). Results show insignificant effect of dietary treatment on LBW of she-calves during pre-, at and post-natal period, but only weight gain during pre-natal period was higher ($P<0.05$) in G3 than in G1 and G2. Average daily milk yield (ADMY) was higher in G2 and G3 than in G1, but the differences were not significant. Milk composition levels were not affected by dietary treatment. However, dietary treatment increased ($P<0.05$) level of blood triglycerides, cholesterol, HDL and LDL, being the highest in G3. Final LBW of calves at 28 wk of age and average daily gain of calves (0-28 wk) were higher in G3 than in G1 and G2.

In conclusion, dietary supplementation of CSFA of palm oil at a level of 6% improved milk production of dromedary camels in term of increased milk yield as well as yield of fat, protein and lactose in milk, reflecting higher LBW and gain of their offspring.

Key words: Camel calves, dromedary camel, live body weight, milk production, protein and lipid metabolism

Camels are able to maintain their appetites even under harsh conditions and a great amount of available food will support a greater weight of camel (Gihad *et al,* 1989). Camels are dairy animals with a good potential (Knoess, 1979; Breulmann *et al,* 2007). It was assumed that energy requirements of pregnant camels increase rapidly during the last stage of pregnancy because pregnancy period is long (Al-Zamely, 2011). The productivity of camels is relatively lower when compared with other species and this was attributed to poor feeding conditions available to camels in their natural habitat (Topps, 1975; Mousa *et al,* 1983).

Energy is the critical nutrient for milk production (Morand-Fehr and Sauvant, 1978) and fat sources play an important role in increasing energy density of the diet (Groehn *et al,* 1992). One of the limitations on the use of fat supplements to ruminants has been the potential negative effects of fat on fibre digestion in the rumen (Palmquist, 1984; Jenkins, 1993). These deleterious effects have been associated with an inhibition on microbial activity, particularly that of cellulolytic and methanogenic microorganisms (Palmquist, 1984). Therefore, resistant dietary fat as calcium soap of fatty acids (CSFA) could be used to increase the energy concentration of the diet to meet the high energy requirements of animals particularly during the critical phase of early lactation (with higher utilisation (Antongiovanni *et al,* 2002; Gargouri *et al,* 2006). The amount of CSFA added to the diet may affect dry matter intake if it exceeds 6% (Mele *et al,* 2005). Feeding trials with CSFA of palm oil have shown variable results in lactating goats (Chilliard *et al,* 2003; Mostafa *et al,* 2012 a&b). Increasing dietary energy with low protein level contributed to higher milk yield in camels (Al-Saiady *et al,* 2012).

Camel's milk is much more nutritious than that from a cow. It is lower in fat and lactose, and higher in potassium, iron and vitamin C (Konuspayeva *et al,* 2009). Daily milk yield from she-camel vary from 15 to 40 kg which means 3.3 to 8.9% of body weight (Knoess, 1979). Milk production of the she-camel was estimated to range from 1500 to 3000 kg/ annum (Faye, 2004 and Hassan, 1994). Average daily

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milk yield of camel varied between 2 and 12 kg in Kenya (Field, 1979), 7-18 kg in India (Roa, 1974) and 3.5-4.5 kg in Egypt (El-Bahey, 1962). Regarding milk composition, total solids, protein, fat, lactose and ash were 11.96, 2.8, 3.5, 4.6 and 0.79% (Mehaia, 1994).

The current study was aimed to evaluate the effect of increasing the density of dietary energy by inclusion of 3 and 6% CSFA of palm oil on productive performance of lactating dromedary camels.

Materials and Methods

This study was carried out at the Camel Research Station, Marsy Matrouh, belonging to Animal Production Research Institute, Agricultural Research Centre during the period from January, 2012 to June, 2012.

Animals and feeding system:

Nine pregnant dromedary she-camels (average live body weight of 452.61±35.12 kg and within the 2 and 3 parity) in the last three months of pregnancy were used in this study. Animals were divided according to LBW and parity to three treatment groups, three animals in each.

All experimental animals were fed basal diet in similar amounts for each group during pre-natal {4.5 kg concentrate feed mixture (CFM); 2 kg berseem hay (BH) and 2 kg rice straw (RS)} and during post-natal period (3.5 kg CFM; 2.5 kg BH and 2 kg RS). Ingredients of CFM and chemical analysis of CFM, BH and RS are shown in Table 1. The CFM used in feeding all the experimental animals was composed of 25% wheat bran, 25% yellow corn, 9% un-corticated cotton seed meal, 20% barely, 15% rice brain, 3% molasses, 2% premix and 1% common salt. Chemical analysis of CFM, BH and RS is shown in Table 1.

Animals in the 1st group (control) were fed the basal diet without any supplements, while those in the 2nd and 3rd groups were fed daily basal diet supplemented with 3% (about 250 g/h/d) and 6% (about 500 g/h/d) oil of calcium salt of fatty acids (CSFA), respectively. Samples of CFM without supplementation were taken for chemical analysis. Oil of CSFA contained 84% fatty acids of palm oil, 12.5% calcium oxide, 3.485% moisture and 0.015% antioxidant (BHT). Fatty acids of palm oil contained 1.5% myristic acid, 44% palmitic acid, 5% stearic acid, 40% oleic acid and 9.5% linoleic acid.

The CFM of treatment groups was mixed with its supplement immediately before feeding and each determined supplement was satisfactory mixed with the ingredients of CFM. 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-natal period).

Table 1. Ingredients of concentrate feed mixture (CFM) and chemical analysis (on DM basis) of different feed stuffs in the basal diet of she-camels in all groups.

Nutrient	CFM	BH	RS
DM (%)	89.44	89.0	88.46
Chemical analysis (%):			
OM	92.43	87.7	82.24
CF	8.85	30.5	35.69
CP	12.24	11.30	2.53
EE	4.64	3.20	1.52
NFE	66.70	37.70	40.50
Ash	7.57	12.3	19.76

CFM: Concentrate feed mixture. BH: Berseem hay
RS: Rice straw

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 27 weeks post-natal. Milk samples of each animal (mixture from morning and evening milking) were monthly taken for the determination of milk composition at the 1st, 2nd, 4th and 6th month of lactation period.

Blood sampling:

Animals in each experimental group were bled one week pre- and 1, 2, 4, 5 and 6 weeks post-natal period. Bleeding was done before morning feeding. During each bleeding time, blood was collected from each animal by jugular vein-puncture into test-tube. 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 analysed for total proteins, albumin, triglycerides, cholesterol, high density lipoproteins (HDL). Also, activity of transaminases, AST and ALT as well as hormonal concentration of estradiol (E2) and progesterone (P4) was also determined in blood serum. However, concentration of globulin and low density lipoprotein (LDL) was calculated.

Experimental procedures:

At starting the experimental period (3 months pre-natal), experimental camels in all groups were

weighed to get the initial LBW, then animals were biweekly weighed during other three months post-natal. Animal were housed individually and fed one of the three experimental diets and water was offered all day time. Also, LBW of camel calves produced from each group was recorded and then weight gain was calculated during post-natal period.

Chemical analysis

The dried samples of the feeds (concentrates, berseem hay and bean straw) were ground and further dried at 105°C for one hour to determine the dry matter (DM). Chemical analysis of feeds was determined after the official methods of AOAC (1980), while chemical analysis of milk was determined using milko-Scan (Model 133 B).

Statistical analysis

Data obtained in this study were statistically analysed by ANOVA using the General Linear Model (GLM) procedures of the statistical Analysis Systems (SAS, 1999, version 8.0) to test group differences at each period/interval. The differences between least squares means were declared significant at P<0.05 using Duncan (1955).

Results and Discussion

Live body weight

Results shown in Table (2) revealed that the differences in LBW of she-camels during pre-, at and post-natal periods as well as change in LBW during post-natal period were not significant. However, significant (P<0.05) effect of treatment was recorded on LBW change only during pre-natal period. She-camels in both treatment groups (3 and 6% CSFA) gained significantly (P<0.05) higher weight than the control camels.

The noticed increase in she-camel weight during pre-partum, being higher in treatment groups than in the control group, was associated with advancing pregnancy and increasing growth of embryos to foetuses. At natal, camels in all groups lost body weight, being higher in treatment groups than in the control group, which was in relation to birth weight of camel calves. Such trend may suggest some beneficial effects of dietary supplementing CSFA of 3 or 6% palm oil on LBW of camels during pre- and post-natal periods. Impact of dietary supplementation of CSF on animal LBW was observed by some others. In this respect, body weight of ewes tended to be higher for diet supplemented with CSFA of olive (Perez Alba *et al,* 1997) or calcium salts of long chain fatty acids (El-Shahat *et al,* 2010).

Table 2. Average live body weight (kg) of she-camel fed calcium salt of palm oil during pre-, at and post-natal periods.

Item	Live body weight (kg)		
	Control	3% calcium salt	6% calcium salt
Pre-natal period:			
12 wk	455.00±2.887	460.00±47.258	443.33±29.059
10 wk	463.33±1.667	469.00±47.823	452.00±28.449
8 wk	471.33±1.333	474.67±47.506	464.67±29.452
6 wk	482.00±3.606	494.67±43.183	488.33±27.437
4 wk	493.67±1.333	509.67±47.907	506.00±27.154
2 wk	504.67±2.667	519.67±45.057	524.67±26.710
LBW change/d[1]	0.709±0.021[b]	0.852±0.045[b]	1.162±0.122[a]
At natal	469.00±11.676	471.00±47.353	475.00±27.301
Post-natal period:			
2 wk	475.33±9.821	480.00±50.408	493.67±36.191
4 wk	481.67±8.353	485.33±49.991	500.00±36.116
6 wk	490.33±7.667	491.33±48.457	506.33±33.766
8 wk	497.00±6.557	509.00±44.377	512.00±31.182
10 wk	502.33±6.173	520.67±41.579	522.33±28.026
LBW change/d[2]	0.476±0.083	0.710±0.083	0.676±0.0290

1: daily change in LBW during 10 wk pre-natal. 2: Daily change in LBW during 8 wk post-natal.

[a and b:] Means within the same row with different superscripts are significantly different at P<0.05.

The insignificant differences among the experimental groups in LBW of she-camels during pre-natal period were observed in ewes (Casals *et al,* 2006; Purushothaman *et al,* 2008) and cows (Schauff *et al,* 1992) fed ration containing palm oil. Generally, camels are able to maintain their appetites even under harsh conditions and a great amount of available food will support a greater weight of camel (Gihad *et al,* 1989).

Milk production

Milk yield

Results presented in (Fig 1) show insignificant effect of treatment on average daily milk yield (ADMY) during lactation intervals from the 2nd up to 27th week, although ADMY tended to be higher in 6% CSFA group than in 3% CSFA and the control groups at most lactation weeks. Several studies on the effect of fat supplementation to dairy animals revealed contradictory results. The present results agreed with those obtained recently by Mostafa *et al* (2012a) on goat does fed different types of CSFA, by Appeddu *et al* (2004) and Gargouri *et al* (2006) on ewes and Otaru *et al* (2011) goats fed diets supplemented with fat.

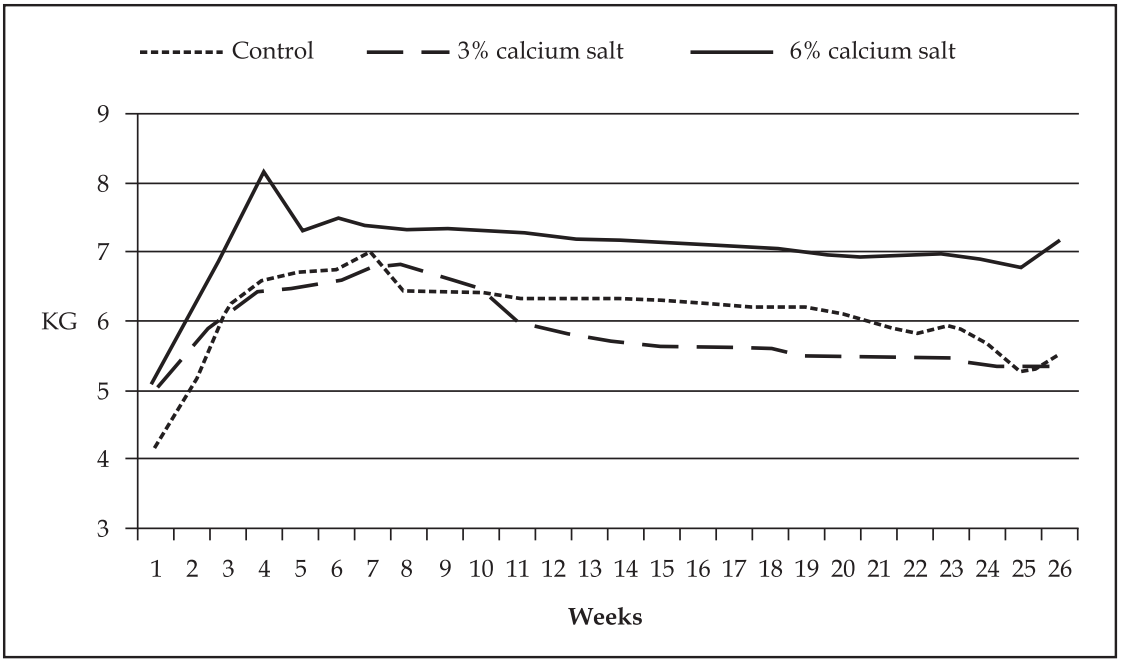

Fig 1. Average daily milk yield (kg/d) of she camels in calcium salt oils (3 and 6%) and control groups at different lactation weeks.

However, Al-Dobaib (2009) found that ADMY reduced ($P<0.05$) in camels fed 1.5 and 3% palm oil compared with controls. Also, Davison *et al* (1991) found that fat supplementation have a nonsignificant ($P>0.10$) trend of increased milk yield for cows in mid lactation.

Dietary energy supplements are usually more effective in enhancing milk yield in high genetic merit animals or high yielders (Gihad *et al,* 1987).

The obtained results may indicate beneficial effect of palm oil inclusion in ration of camels, but the effect was not significant, because lower number of animals within each experimental group was used in this study (n=3). Response to fat supplementation could be affected by the small number of animals used per treatment as well as the variability of the animals (Gargouri *et al* (2006), and the increase in milk production of approximately 5% could not be detected as significant if less than 10 cows per treatment were used (Palmquist and Conrad, 1978).

Milk production is generally increased by the inclusion of fat in confined feeding systems (Chilliard *et al,* 1993; Wu and Huber, 1994), although high variability existed in the level of response. The effect of fat supplementation on the milk yield depends upon the degree of saturation. It has been found that milk yield increased by the addition of saturated but not unsaturated fatty acids (Gagliostro and Chilliard, 1992). It has been also suggested that the maximum milk production response to fat supplementation is not achieved until cows are in a positive energy balance (Davison *et al,* 1991; Skaar *et al,* 1989).

She-camels in the control group showed the lowest ADMY ranging between 4.2 and 7.0 kg versus moderate values (5.0-6.8 kg) in 3% palm oil group and the highest yield (5.1-8.1 kg) in 6% palm oil group during 2-27 wk of lactation. Average daily milk yield of camel varied between 2 and 12 kg in Kenya (Field, 1979), 7-18 kg in India (Roa, 1974) 3.5-4.5 kg in Egypt (El-Bahey, 1962).

Milk composition

Results presented in Table 3 showed insignificant effect of dietary treatment on milk contents including fat, protein, lactose and solids not fat percentages, at the 2nd, 4th and 6th month of lactation. There was a tendency of higher ADMY of treatment groups than in control one (Table 3). Such trend may lead to increased yield of fat, protein and lactose. Faye *et al* (2008) recorded a negative correlation between milk yield and fat percentage. It is of interest to note that she-camels in 6% palm oil group maintained fat percentage in milk during the 1st six weeks of lactation, but those in 3% palm oil and control groups showed marked reduction by advancing lactation week.

In agreement with the present results, Al-Dobaib (2009) found no significant effect of dietary

palm oil supplementation on camel milk components (fat, solids non-fat, ash, protein and lactose). However, Al-Saiady *et al* (2012) reported that dietary energy level did not affect camel milk composition, except on fat and ash percentages. Also, insignificant effect of dietary palm oil supplementation on fat, protein and lactose contents was reported in goat (Mostafa *et al,* 2012a), ewe (Purushothaman *et al,* 2008) and cow (Klusmeyer *et al,* 1991). Moreover, Brzoska *et al* (1999) reported that increasing amount of calcium salt of palm oil fatty acids had no negative effect on cow milk fat, protein and lactose contents. On the other hand, Schmidely and Sauvant (2001) indicated a positive effect of CSFA on the ewe's milk fat content.

The camel milk components of persent study including fat, protein and total solids were 3.8-5.9%, 4.1-4.8% and 11.0-13.1%, respectively whereas the normal range of fat, protein and total solids were 3.5-5.5, 2.8-4.5 and 11.96-14.4% respectively as reported by Mehaia (1994) and Kenoess (1976). However, the present values of lactose in this study was higher (6.07-7.09%) than that reported by the previous authors (3.4-4.6%).

Blood parameters

Protein metabolism

Effect of dietary treatment on protein metabolism pre-, at and post-natal periods is presented in Table 4. Results showed insignificant group differences in concentration of total proteins (TP), albumin (AL) and globulin (GL) in blood serum of she-camels pre-, at and post-natal periods, although both treatment groups tended to show higher values than those in the control group at each period.

It is of interest to note that concentration of TP, AL and GL in all groups showed slight changes at natal as compared to pre-natal period, thereafter increased at post-natal weeks (1st to 6th wk) as compared to that at natal and post-natal period (Table 4).

There is significant decrease ($P<0.05$) in total proteins concentration in pregnant camel as compared with non pregnant (Al-Zamely, 2011). This decrease may be due to transport of amino acids and protein to the placenta (Writs Chafter and Portland, 1958). It is known that progesterone increased over 1 ng/ml in camels during pregnancy (Elias *et al,* 1984), which may affect liver and cause decreasing albumin production (Pineda and Dooley, 2003) during pregnancy. An increase of albumin elimination by kidney during pregnancy also plays a role in decreasing albumin level during pregnancy (Halliwell, 1988) as compared to after pregnancy. The decrease of albumin in pregnant as compared to non-pregnant camels (Al-Zamely, 2011), leads to a decrease in total proteins because albumin is the main component of total protein (Champe and Harvey, 2005). The decrease of total protein during pregnancy leads to decrease in protein synthesis in the liver (Sikka, 2004).

Table 3. Milk contents of she camels fed calcium salt oils during pre- and post-natal periods.

Milk content (%)	Post-natal month	Control	3% calcium salt	6% calcium salt
Fat	2nd	5.01±0.626	5.73±0.356	4.99±0.528
	4th	4.35±0.641	5.89±0.450	5.56±0.302
	6th	3.82±0.257	4.65±0.740	5.14±0.592
Protein	2nd	4.17±0.158	4.37±0.141	4.82±0.351
	4th	4.07±0.239	4.73±0.165	4.47±0.237
	6th	4.05±0.507	4.12±0.529	4.21±0.140
Lactose	2nd	6.24±0.240	6.55±0.211	6.90±0.262
	4th	6.10±0.357	7.09±0.250	6.87±0.266
	6th	6.07±0.757	6.18±0.793	6.30±0.208
Solids not fat	2nd	11.47±0.426	11.91±0.386	13.16±0.948
	4th	11.11±0.649	12.89±0.453	11.62±1.117
	6th	11.06±1.381	11.11±1.575	11.48±0.375

There are no significant differences.

Lipid metabolism

Effect of dietary treatment on lipid metabolism pre-, at and post-natal periods is presented in Table 5. Contrary to protein metabolism, the differences in lipid metabolites including concentration of triglycerides (TG), total cholesterol (TC) and HDL among the experimental groups were significant ($P<0.05$). Concentration of serum TG, TC and HDL significantly ($P<0.05$) increased in both treatment groups than in the control one pre-natal, at natal and 1st six weeks of post-natal period, being almost the highest in 6% palm oil group, except for TC concentration at natal, the differences were non-significant. However, the effect of treatment on serum LDL concentration was significant only at 4th, 5th and 6th week of post-natal period, being higher by palm oil supplementation at level of 6% than 3% palm oil and control group (Table 5).

The concentration of lipid metabolites (TG, TC, HDL and LDL) in all groups showed marked reduction at natal as compared to pre-natal period, then all metabolites showed gradual increase during post-natal period from 1st up to 6th week (Table 5).

Table 4. Concentration of total proteins and their fractions in blood plasma of she camels fed calcium salt oils during pre- and post-natal periods.

Parameter	Period	Control	3% calcium salt	6% calcium salt
Total proteins	Pre-natal	5.587±0.105	5.855±0.244	6.330±0.337
	At natal	5.395±0.079	5.491±0.148	5.556±0.258
	1 wk post-natal	5.948±0.104	6.136±0.211	6.235±0.165
	2 wk post-natal	6.132±0.219	5.982±0.173	6.591±0.330
	4 wk post-natal	6.465±0.226	6.649±0.160	7.258±0.337
	5 wk post-natal	6.681±0.219	6.952±0.353	6.935±0.185
	6 wk post-natal	6.613±0.112	6.669±0.239	6.849±0.218
Albumin	Pre-natal	2.995±0.147	2.607±0.300	3.284±0.189
	At natal	2.822±0.247	2.457±0.099	2.414±0.164
	1 wk post-natal	2.885±0.025	2.784±0.133	2.492±0.310
	2 wk post-natal	2.588±0.165	3.068±0.248	3.226±0.285
	4 wk post-natal	3.181±0.136	3.386±0.078	3.395±0.237
	5 wk post-natal	3.402±0.295	3.585±0.154	3.383±0.128
	6 wk post-natal	3.320±0.121	3.309±0.074	3.358±0.028
Globulin	Pre-natal	2.592±0.242	3.249±0.406	3.046±0.249
	At natal	2.573±0.317	3.034±0.108	3.140±0.247
	1 wk post-natal	3.063±0.101	3.353±0.239	3.744±0.296
	2 wk post-natal	3.544±0.221	2.915±0.346	3.365±0.255
	4 wk post-natal	3.285±0.116	3.263±0.128	3.863±0.369
	5 wk post-natal	3.280±0.344	3.368±0.278	3.552±0.205
	6 wk post-natal	3.293±0.199	3.359±0.211	3.491±0.239

There are no significant differences

In accordance with increasing concentration of serum lipid metabolites, Palmquist and Jenkins, (1980) found that the uptake and direct incorporation of long chain fatty acids into TG by mammary gland are increased when fat is included in the ration. Also, blood TC concentration significantly increased in dairy cows fed diets supplemented with linseed oil (Loor *et al,* 2005) and sheep supplemented with palm oil (Lough *et al,* 1993). Increased dietary lipid also increased plasma TC (Williams, 1996).

Moreover, Ghoreishi *et al* (2007) reported that serum concentrations of TC, TG and HDL were significantly greater for ewes fed diet supplemented with palm oil as compared with the control ewes, but LDL concentration was not significantly affected. Fat supplementation also increased the serum levels of TC and HDL in cows (Funston, 2004) and ewes (Espinoza *et al,* 1998).

The present study indicated significant increase in HDL in association with increased TC concentration following palm oil feeding. The correlation coefficient between HDL and TC levels following CSFA feeding of ewes was 0.36 (P<0.05, Ghoreishi *et al,* 2007). HDL represents the majority of total plasma lipoprotein cholesterol (Bao *et al,* 1995, 1997). In agreement with the present results, Kuran *et al* (1999) reported a significant increase in LDL levels of CSFA-supplemented ewes. Lipid supplementation of ewes also increased TC and HDL levels.

Enzymatic activity

Results presented in Table 6 showed that activity of transaminases (AST and ALT) were not affected significantly by dietary treatment during pre-natal period and at natal. However, activity of both enzymes was affected significantly (P<0.05) by dietary supplementation of palm oil. Dietary inclusion of 3 or 6% palm oil significantly (P<0.05) increased AST activity from 1st up to 6th week, and significantly (P<0.05) decreased activity of ALT from 2nd up to 6th week in blood serum of she-camels as compared to the control diet.

Results also revealed that AST and ALT activities in all groups showed gradual increase from pre- up to post-natal period (Table 6). In contrast to camel, Mostafa *et al* (2012 b) found no significant

Table 5. Concentration of triglycerides, cholesterol, HDL and LDL in blood plasma of she camels fed calcium salt oils during pre- and post-natal periods.

Parameter	Period	Control	3% calcium salt	6% calcium salt
Triglycerides	Pre-natal	17.794±0.749[c]	23.736±1.262[b]	24.280±0.858[a]
	At natal	14.708±0.885[b]	19.761±0.562[a]	17.752±0.969[a]
	1 wk post-natal	17.998±0.760[b]	22.967±0.987[a]	23.831±1.967[a]
	2 wk post-natal	18.209±0.977[b]	21.678±0.980[ab]	23.933±1.287[a]
	4 wk post-natal	19.710±0.726[b]	26.776±0.811[a]	28.130±0.770[a]
	5 wk post-natal	19.623±0.436[b]	25.654±1.171[a]	28.002±0.894[a]
	6 wk post-natal	18.401±0.197[c]	26.324±0.319[b]	28.584±0.605[a]
Total cholesterol	Pre-natal	65.187±2.240[b]	73.828±1.394[a]	76.497±0.820[a]
	At natal	52.772±0.841[b]	58.307±0.849[a]	61.112±1.643[a]
	1 wk post-natal	58.294±1.767[b]	63.323±0.578[a]	66.812±0.656[a]
	2 wk post-natal	62.846±1.330	67.527±2.237	69.402±1.926
	4 wk post-natal	65.057±1.223[b]	73.912±0.506[a]	76.856±0.911[a]
	5 wk post-natal	62.914±1.130[c]	70.749±0.933[b]	78.102±1.365[a]
	6 wk post-natal	63.742±0.592[c]	72.362±1.013[a]	79.899±0.888[b]
HDL	Pre-natal	26.946±1.122[b]	36.284±0.550[a]	38.066±0.758[a]
	At natal	24.869±1.102[b]	30.917±0.871[a]	32.235±0.959[a]
	1 wk post-natal	26.401±0.632[b]	30.185±1.475[a]	30.973±0.645[a]
	2 wk post-natal	29.937±0.132[b]	34.617±1.008[a]	35.968±0.830[a]
	4 wk post-natal	28.479±1.034[b]	32.063±0.442[a]	33.446±0.543[a]
	5 wk post-natal	30.591±0.915[b]	37.077±1.946[a]	37.196±1.302[a]
	6 wk post-natal	30.558±0.491[c]	36.176±0.690[b]	38.348±0.549[a]
LDL	Pre-natal	34.682±3.034	32.797±1.179	32.975±1.180
	At natal	24.961±1.571	23.438±0.315	25.327±0.782
	1 wk post-natal	28.294±1.363	28.546±2.173	31.073±0.318
	2 wk post-natal	29.267±1.332	28.575±2.053	28.646±2.551
	4 wk post-natal	32.635±0.535[b]	36.494±0.234[a]	37.784±1.113[a]
	5 wk post-natal	28.398±1.424[b]	28.542±1.664[b]	35.306±0.498[a]
	6 wk post-natal	29.503±1. 010[b]	30.921±0.433[b]	35.834±1.409[a]

[a, b and c]: Means within the same row with different superscripts are significantly different at P<0.05.

Table 6. Activity of AST and ALT in blood plasma of she camels fed calcium salt oils during pre- and post-natal periods.

Parameter	Period	Control	3% calcium salt	6% calcium salt
AST	Pre-natal	40.647±0.579	43.972±0.888	41.981±0.877
	At natal	40.628±0.586	42.526±0.470	41.385±0.809
	1 wk post-natal	43.986±0.880[b]	47.988±0.671[a]	47.997±0.887[a]
	2 wk post-natal	48.000±1.199[b]	51.984±0.883[a]	52.997±0.875[a]
	4 wk post-natal	50.549±0.497[b]	54.649±0.569[a]	54.655±0.578[a]
	5 wk post-natal	50.610±0.597[b]	54.643±0.579[a]	55.042±0.829[a]
	6 wk post-natal	49.067±0.875[b]	55.086±0.296[a]	56.217±0.812[a]
ALT	Pre-natal	13.913±0.338	14.614±0.563	14.231±0.346
	At natal	17.207±0.306	17.139±0.371	16.104±0.254
	1 wk post-natal	17.587±0.556	17.287±0.331	17.250±0.299
	2 wk post-natal	19.921±0.350[a]	17.917±0.322[b]	17.932±0.349[b]
	4 wk post-natal	19.585±0.553[a]	17.261±0.315[b]	17.282±0.283[b]
	5 wk post-natal	19.630±0.405[a]	17.594±0.573[b]	17.373±0.210[b]
	6 wk post-natal	20.023±0.278[a]	17.036±0.318[b]	16.850±0.373[b]

[a and b]: Means within the same row with different superscripts are significantly different at P<0.05.

effect of different types of CSFA on activity of AST and ALT in serum of goats.

Hormonal concentration

Effect of dietary treatment on hormonal concentration of progesterone (P4) and estradiol (E2) pre-, at and post-natal periods is presented in Table (7). Results showed insignificant group differences in concentration of P4 and E2 in blood serum of she-camels pre-, at and post-natal periods, but the hormonal values in each group varied according to the reproductive status. Similary, Espinoza *et al* (1998) in ewes did not find a significant effect of CSFA on P4 concentration.

Concentration of P4 and E2 was higher pre-natal than at and post-natal period in all groups. It is worth noting that P4 level was almost above 1 ng/ml in all groups indicating higher ovarian activity during the breeding season in Egypt.

The supply of lipoproteins plays significant role in regulating ovarian steroidogenesis (Williams, 1996). Progesterone hormone level in females is a very useful tool to monitor pregnancy in camels (Alfuraiji, 1998). All camelids depend entirely on progesterone from the CL to maintain their pregnancy (Skidmore, 2005). The present study indicated that P4 level ranged between 4.5-6.0 ŋg/ml during pre-natal period in all groups. In this respect, Elias *et al* (1984) observed that P4 level increased over 1 ng/ml in pregnant camels.

The observed moderate values of P4 above 1 ng/ml and increasing E2 level during post-natal period in all groups indicated higher ovarian activity and breeding season of camel during the experimental period (March – May). Several authors found that plasma progesterone level remains very low throughout the follicular wave in the absence of mating and ovulation (Ismail *et al,* 1998; Ayoub *et al,* 2003; Skidmore, 2005; Ghazi, 2007). However, moderate P4 values were recorded during summer months in Egypt (Hussein *et al,* 2008 and Zeidan *et al,* 2011). The noticed moderate level of E2 at early post-natal weeks may suggest presence of small follicles, which secrete E2, but not in amounts sufficient to induce the ovulatory surge of LH (Deen, 2008).

On the other hand, dietary supplementation of CSFA increased P4 concentration in ewe serum (Kuran *et al,* 1999). In this way, serum concentrations of P4 was significantly greater for ewes fed basal ration plus 80 g CSFA as compared with the control ewes (Ghoreishi *et al,* 2007). In this respect, Hawkins *et al* (1995) suggested that the increase in plasma P4 in cows on lipid-supplemented diets may not be due to increased P4 synthesis but rather to its reduced clearance from the circulation. However, Kuran *et al* (1999) showed that the luteal tissue from lipid-fed ewes secreted higher amounts of P4 *in vitro* than that from the control. Therefore, increased plasma P4 levels could be due to increased synthesis of P4 following increased availability of cholesterol (Spicer *et al,* 1993) and (or) lipoproteins (Bao *et al,* 1995) and as well as reduced clearance from circulation.

Live body weight of camel calves:

Data presented in Table (8) show significant ($P<0.05$) differences in LBW of calves produced from

Table 7. Concentration of progesterone and estradiol in blood plasma of she camels fed calcium salt oils during pre- and post-natal periods.

Hormone	Period	Control	3% calcium salt	6% calcium salt
Progesterone (ng/ml)	Pre-natal	4.561±0.320	5.926±0.285	6.015±0.487
	At natal	1.207±0.030	1.296±0.178	1.443±0.174
	1 wk post-natal	1.373±0.098	1.226±0.094	1.248±0.064
	2 wk post-natal	2.074±0.133	2.096±0.111	2.043±0.358
	4 wk post-natal	2.360±0.233	2.162±0.021	2.216±0.164
	5 wk post-natal	1.577±0.169	1.978±0.186	1.981±0.253
	6 wk post-natal	1.415±0.115	1.301±0.086	1.381±0.202
Estradiol (pg/ml)	Pre-natal	274.609±58.646	330.352±26.552	326.079±52.965
	At natal	40.712±2.707	46.628±2.561	41.547±1.958
	1 wk post-natal	18.246±0.708	19.340±1.380	18.279±1.199
	2 wk post-natal	13.168±0.606	13.853±0.767	13.533±0.749
	4 wk post-natal	19.726±0.569	19.575±1.219	20.308±0.781
	5 wk post-natal	19.546±0.415	19.782±0.706	19.184±0.510
	6 wk post-natal	22.264±0.643	21.747±0.881	21.876±0.442

There no significant differences.

Table 8. Average of live body weight and daily gain of calves produced by she camel fed calcium salt oils during pre- and post-natal periods.

Item	Control	3% calcium salt	6% calcium salt
Average live body weight (kg):			
At natal (0 time)	29.83±3.032	27.67±3.245	27.17±2.351
4 wk	39.67±5.239	38.67±4.631	33.33±2.728
8 wk	50.67±5.207	52.23±3.180	43.00±3.464
12 wk	69.67±8.876	69.33±8.950	64.00±8.185
16 wk	95.00±7.638	91.33±11.407	89.00±9.713
20 wk	109.67±8.667	117.33±10.269	114.67±7.965
24 wk	120.00±7.234	134.33±6.984	138.33±4.410
28 wk	132.33±6.360^{c}	157.67±3.844^{b}	167.33±2.729^{a}
Average daily gain (kg/d):			
0-4 wk	0.351±0.096	0.393±0.132	0.220±0.033
4-8 wk	0.393±0.055	0.488±0.202	0.345±0.043
8-12 wk	0.679±0.209	0.607±0.223	0.750±0.179
12-16 wk	0.905±0.095	0.786±0.109	0.893±0.055
16-20 wk	0.524±0.114^{b}	0.929±0.094^{a}	0.917±0.063^{a}
20-24 wk	0.369±0.052	0.607±0.238	0.845±0.131
24-28 wk	0.440±0.093^{c}	0.833±0.114^{b}	1.036±0.062^{a}
0-28 wk	0.523±0.020^{c}	0.663±0.036^{b}	0.715±0.005^{a}

$^{a, b \text{ and } c}$: Means within the same row with different superscripts are significantly different at P<0.05.

different experimental groups only at 28 weeks of age. At 28 weeks of age, calves of treatment groups were significantly (P<0.05) heavier than those of the control group, but calves of 6% palm oil group were significantly (P<0.05) than those of 3% palm oil group.

Regarding average daily gain (ADG), calves of 6% palm oil group showed significantly (P<0.05) heavy LBW at the intervals of 16-20 wk and 24-28 wk and at overall of 28 wk of age.

The impact of CSFA supplemented to dam diets on their offspring was reported recently in goats (Mostafa *et al,* 2012 a). Also, mean lamb birth weight of CSFA supplemented ewes was significantly greater than non-supplemented ewes, although total lamb birth weight was not significantly affected by feeding CSFA. The ADG of lambs born to CSFA supplemented ewes were significantly higher than for non-supplemented ewes (Ghoreishi *et al,* 2007). However, fat supplementation did not improve lamb birth weight in several studies (Espinoza *et al,* 1998; Casals *et al,* 1999).

In conclusion, dietary supplementation of palm oil at 3 or 6% affected activity of transaminases and lipid metabolism without adverse effects on P4 and estrogen concentrations. Therefore, dietary supplementation of CSFA of palm oil at a level of 6% improved milk production of dromedary camels in term of increasing milk yield as well as yield of fat, protein and lactose in milk, reflecting higher LBW and gain of their offspring.

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