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Effect of Palm Oil Supplementation on the Milk Yield and Composition of Dromedary She Camels

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Abstract: Three diets were formulated according to percentage of palm oil added (C, control 0%; D1, 1.5%; D2, 3%) and offered to nine adult milking she camels. Camels were randomly allotted into three diets (3 animals each) and each diet shifted in three periods. Each period was splitted into 2 weeks for acclimatization and 2 weeks for data collection. Camels were machine milked twice a day (morning and afternoon). Animals were individually fed since feed and water were offered as free choice. Daily feed intake, milk yield and milk chemical composition were recorded. Obtained results showed significant effect of diets on daily feed consumption and daily milk yield. Adding palm oil in the diet resulted in a significant decrease in feed consumption (8.79, 7.94 and 7.05 kg/day for C, D1 and D2, respectively). Likewise, daily milk yield decreased significantly in treated females (2.89, 2.79, 2.46 kg/day for C, D1 and D2, respectively). Supplementing diets with palm oil at 1.5 and 3% didn't affect milk composition (total solids, moisture, solid not fat, ash, fat, protein and lactose). Although, slight, but not significant increases in percent of milk fat (2.82, 3.02 and 3.01% for C, D1 and D2 respectively) were obtained, animals exhibited significant individual variations in milk composition. Addition of palm oil didn't significantly influence milk calcium, sodium, potassium, phosphorus, magnesium, ferrous, manganese, zinc and sulphur. However, copper increased at D2 diet (4.76 ppm) than at control and D1 (3.04 and 3.31 ppm, respectively). It can be concluded that supplementing diets of milking she-camels with palm oil at the tested levels in this study caused a reduction in feed intake and milk yield but did not affect their milk composition except for a significant increase in the concentration of copper in camels that received 3% palm oil.

Key words: Dromedary camel, diet, fat supplement, palm oil, milk yield and composition

INTRODUCTION

Camel has long been known as a desert animal which tolerates harsh environmental conditions (high ambient temperatures, scarcity of water and food, strong sandstorm.... etc). In spite of these adverse conditions camels are able to survive, reproduce and produce milk, meat and wool. However, 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). This attracted researchers to investigate the optimum nutrient requirements for dairy camels. It was found that there are individual variations within and among species in milk production and composition. (El-Bahey, 1962; Field, 1979). Several factors (i.e. feedstuffs, number of milking per day, health status, genetic makeup, age and water availability) have been known to influence milk yield and composition. The most influential factor, in this respect, is the quantity and quality of the available feedstuffs.

Camel female milk yield in Kenya has been varied between 2 and 12 kg milk per day (Field, 1979), while Roa (1974) in India reported a milk yield of 7-18 kg/day. El-Bahey (1962) in Egypt obtained 3.5-4.5 kg milk/day. Regarding milk composition, Mehaia (1994) reported that camel milk composition was 11.96, 2.8, 3.5, 4.6 and 0.79% for total solids, protein, fat, lactose and ash, respectively. On the other hand, Kenoess (1976) found respective values of 14.4, 4.5, 5.5, 3.4 and 0.9%. The aim of the present investigation is to study the effect of supplementation of the camel ration with kernel palm oil on the improvement of daily milk yield, composition and feed intake under hot climatic conditions in Saudi Arabia.

MATERIALS AND METHODS

Animals and diets: Three diets were formulated according to percentage of palm oil added (C, control 0%; D1, 1.5%; D2, 3%). The diet composition for each group is shown in Table 1. Nine adult milking she camels were completely randomly allotted into three diets (3 animals each) and each diet shifted in three periods on the same animal. Each period was splitted into 2 weeks for acclimatization and 2 weeks for data collection. Animals were individually fed since feed and water were offered *ad libitium*.

Diets contained concentrate containing 14% crude protein and 61% TDN. Ration was offered as a Pelleted form of TMR. Animals within a group were fed C diet for one month of which 14 days served as acclimatization period and 16 days for data collection. Animals

Table 1: Chemical composition and ingredients of the experimental diets

Ingredient	Diet[1] C	D1	D2
Alfalfa hay	68	68	68
Barley	20	10	0
W Bran	0	7.5	15
Molasses	5	6	7
W straw	6	6	6
Palm oil	0	1.5	3
Dicalsium Phosphate	0.6	0.4	0.2
Salt	0.1	0.3	0.5
Vitamin Premix	0.3	0.3	0.3
Chemical Composition, % as DM basis:			
DM	91.09	90.93	90.77
TDN	61.73	61.96	62.19
Crude Protein	14.30	14.36	14.42
Calcium	0.98	0.95	0.92

[1]C = control diet; D1 = 1.5% palm oil diet; D2 = 3% palm oil diet.

thereafter were switched to diets D1 and D2 for one month each, meaning that animals were tested in a crossover manner.

Milk sampling: She- camels were milked twice daily at 09.00 h and 18.00 h. Samples of 30 ml milk were collected in clean vials containing potassium dichromate as a preservative and kept cooled at 5°C until assayed. Milk yield and daily feed intake were recorded.

Chemical analyses of milk: Milk samples were analyzed for total solids, fat, Solid non Fat (SNF), protein, lactose and ash according to the procedures outlined in AOAC (1990). Fat was determined by the Gerber method, protein by micro Kjeldahl with a nitrogen conversion factor multiplied by 6.38 to calculate protein content of milk samples and lactose was determined by subtraction.

Mineral determinations in milk: Milk samples were ashed and ash was dissolved in 20% HCL. For calcium and magnesium determinations 1% lanthanum was added to the final dilution to overcome phosphate interference. All measured minerals, except phosphorus, were determined by Pye Unicam atomic absorption spectrophotometer (USA). Phosphorus was determined spectrophotometrically (Milton Roy Spectronic 21D, USA). Samples were measured in duplicates and reagents were of analytical grade.

Statistical analyses: Data were analyzed using GLM procedure of SAS program (SAS, 1999). Daily milk yield, feed intake and minerals components in the milk were analyzed using the following model:

$$Y_{ijkl} = \mu + D_i + A_j + P_k + DP_{ik} + E_{ijkl}$$

Where Y_{ijkl} = Observation on ijklth trait; μ = Overall mean; D_i = Effect of ith diet; A_j = Random effect of jth animal; P_k = Effect of kth period; Effect of interaction of D_i x P_k; E_{ijklm} = Random error.

RESULTS AND DISCUSSION

Feed intake and milk yield: Effect of palm oil supplementation on daily feed intake is shown in Table 2. There was a significant ($p<0.01$) decrease in the daily feed intake in treated groups (D1 and D2) when compared with the control animals. Although there were no significant differences in feed intake in DI and D2 groups but it was noticed that there was a tendency for further decrease in feed intake in group D2 that received the higher level of oil (3%) when compared with the group that received 1.5% oil. As presented in Table 2, the daily milk yield (morning and evening) was found to be significantly ($p<0.01$) reduced in treated groups compared with control females. It worth mentioning that the period of milk collection has no effect on the studied traits.

Table 2: Effect of palm oil supplementation in camel ration on daily feed intake and daily milk yield

Item	LS Mean±SE Daily feed intake	Daily milk yield
Diet[1]:		
C	8.83[a]	6.35[a]
D1	7.83[b]	5.63[b]
D2	7.01[b]	5.43[b]
Standard error	0.37	0.21
Period	NS	**
Animal	NS	***
Diet x Period	NS	NS
Residual standard deviations	1.781	0.956
R-Square	0.353	0.755

[1]C = control diet; D1 = 1.5% palm oil diet; D2 = 3% palm oil diet. Means in the same column with different superscripts significantly differ ($p<0.01$).

Several studies on the effect of fat supplementation to dairy animals revealed contradictory results. Davison *et al.* (1991) found that fat supplementation have a non-significant ($p>0.10$) trend of increased milk yield for cows in mid lactation. Moreover, Schroeder *et al.* (2004) stated that total dry matter intake was not consistently affected by fat supplementation. One of the limitations on the use of fat supplements to ruminants has been the potential negative effects of fat on fiber 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).

These effects could be due to the direct action of the fatty acids on the cellular membrane of the microorganisms

and/or due to indirect effects by a reduction in the ruminal availability of cations such as calcium and magnesium (Palmquist, 1988; Jenkins, 1993).

The negative effects increased with the nature of fat source, being highest with medium and long-chain fatty acids and with unsaturated fatty acids (Jenkins, 1993). The reduction in Dry Matter Intake (DMI) has been highly associated with the source and amount of fat supplement used (Coppock *et al*., 1987; Gagliostro and Chilliard, 1991; Wu and Huber, 1994). In non-grazing conditions, total dry matter intake decreased linearly after protected unsaturated (as the case of palm oil) (2.6 kg DMI/kg) or saturated (1.8 kg DMI/kg) fat feeding. The decrease was lower and more variable with CaFA supplementation (r = 0.49), with a mean reduction of 0.6 kg DMI /day with CaFA ($p<0.01$) (Gagliostro and Chilliard, 1991). Another limitation to be considered when fat is added to the concentrate of grazing dairy cows is the potential reduction in the palatability of the concentrate supplement (Grummer *et al*., 1990).

Milk production is generally increased by the inclusion of fat in confined feeding systems (Gagliostro and Chilliard, 1991; Chilliard *et al*., 1993; Wu and Huber, 1994), although high variability existed in the level of response. Early studies (Palmquist and Conard, 1978) reported that the response to fat supplementation in dairy cows was variable and that an increase in milk production of approximately 5% was achieved and could not be detected as significant if less than 10 cows per treatment were used. This could be the case in the present study as three she camels within each group might not give a clear response. Moreover, the effect of fat supplementation on the milk yield and Corrected Fat Milk (CFM) 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, 1991). 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). Also, the decrease ($p<0.01$) in daily feed intake in the present study could represent a major cause of decreased milk production.

Milk composition and minerals: As shown in Table 3, there was no significant effect of supplementation of palm oil on milk components. However, there were no significant changes in fat, solids non-fat, ash, protein and lactose in treated and in control animals.

Similar data were obtained in milk minerals (Table 4) as there were no significant differences in milk sodium, potassium, magnesium, calcium, phosphorus, ferrus, manganese, zinc and sulphur in treated and control animals. Contrariwise, treatment increased ($p<0.05$) copper concentrations in milk.

Supplementing camel diets with palm oil didn't influence total solids, milk moisture, fat, ash and protein or lactose percent in milk. Nature of fat supplemented has significant effect upon milk fat. Schroeder *et al*. (2004) reported that diets supplemented with a source of saturated fatty acids increased milk fat percentage by 5.1% ($p<0.01$), however unsaturated fatty acids (i.e. the case in the current study, palm oil) reduced milk fat percentage (-8.0%, $p<0.01$). The negative effects of unsaturated fat source on milk fat percentage have been described previously (Schingoethe and Casper, 1991; Tackett *et al*., 1996; Garnsworthy, 1997; Bauman and Griinari, 2001; Chilliard *et al*., 2001). Fat supplementation in animal diets affects milk fat percentage and composition by different mechanisms. First, fat feeding may have negative effects on rumen fiber digestion, thus decreasing acetic and butyric acid production affecting *de novo* fat synthesis in mammary gland. Second, when fat is included in the ration the uptake and direct incorporation of long chain fatty acids into triglycerides by mammary gland are increased (Palmquist and Jenkins, 1980).

The uptake of some specific fatty acids (e.g. trans-10, cis-12 conjugated linoleic acid, CLA and trans-8 cis-10 CLA) may also inhibit milk fat synthesis reducing the activity and/or expression of genes that encode important enzymes involved in uptake, synthesis and desaturation of fatty acids in mammary gland (Garnsworthy, 1997; Bauman and Griinari, 2001; Baumgard *et al*., 2002). Therefore, milk fat percentage and composition will result from the balance between an increase in exogenous fatty acid uptake and secretion by the mammary gland and a decrease in *de novo* synthesis. When fat supplement is composed mainly of saturated fatty acids, the balance tended to be positive and increased milk fat percent. However, unsaturated long chain fatty acids appeared to have a negative effect on milk fat percentage. In the present study and as shown in Table 3 no significant change in milk fat percentage was noticed. The addition of palm oil in camel ration at early lactation may have some beneficial effects on this criterion. This finding was confirmed in dairy cows fed fat-protein supplement in early lactation (Strusinska *et al*., 2006). As the milk yield was not increased in the current study, therefore there was no change in milk fat percentage which is attributed to the dilution factor.

Milk protein was not influenced by fat supplementation (Table 3). Previous studies concluded similar trend (Bargo *et al*., 2003; Strusinska *et al*., 2006). Other studies indicated a decrease in milk protein concentration, but its magnitude was not related to the source of fat utilized (Wu and Huber, 1994). The physiological mechanism (s) that explain the reductions in milk protein content with fat feeding are not fully clear. Garnsworthy (1997) postulated that a deficit of glucose, occasioned by the increase in free fatty acids intestinal absorption and the higher synthesis of lactose, may

Table 3: Effect of fat supplementation in camel diets on milk components

	Milk Composition % (LSM±SEM)						
Item	TS	Moisture	SNF	Ash	Fat	Protein	Lactose
Diet[1]:							
C	10.25	89.64	7.32	0.83	2.89	2.10	4.59
D1	10.62	89.47	7.60	0.81	3.03	2.13	4.64
D2	10.47	89.52	7.58	0.82	2.92	2.15	4.39
Standard error	0.13	0.13	0.11	0.01	0.10	0.05	0.11
Period	NS	NS	NS	NS	NS	NS	NS
Animal	***	***	***	*	NS	***	NS
Diet x Period	NS	NS	NS	NS	NS	NS	NS
Residual standard deviations	0.915	0.915	0.685	0.062	0.806	0.318	0.646
R-Square	0.416	0.416	0.428	0.208	0.123	0.234	0.364

[1]C=control diet; D1= 1.5% palm oil diet; D2= 3% palm oil diet.

Table 4: Effect of fat supplementation in camel diets on milk minerals

	Minerals components in milk, ppm (LSM±SEM)					
Item	Na	K	Mg	Ca	P	Fe
Diet[1]:						
C	544.1	1374.3	85.4	658.1	893.3	32.4[ab]
D1	540.8	1403.5	88.4	691.4	896.6	23.9[b]
D2	677.5	1426.0	87.3	671.1	887.5	39.2[a]
Standard error	48.39	22.24	2.21	14.29	24.79	5.15
Period	NS	NS	***	***	***	***
Animal	NS	**	***	***	NS	NS
Diet x Period	NS	NS	NS	NS	NS	*
Residual standard deviations	169.9	78.85	7.210	49.41	88.39	16.32
R-Square	0.405	0.689	0.870	0.720	0.619	0.759

[1]C = control diet; D1 = 1.5% palm oil diet; D2 = 3% palm oil diet. Means in the same column with different superscripts significantly differ ($p<0.05$).

Table 4: (Continued)

	Minerals components in milk, ppm (LSM±SEM)				
Item	Cu	Mn	Zn	Cd	S
Diet[1]:					
C	3.04[b]	0.459	13.366	0.252	18.83
D1	3.31[ab]	0.385	11.091	0.253	20.00
D2	4.76[a]	0.529	16.908	0.347	18.75
Standard error	0.49	0.08	2.54	0.036	2.82
Period	NS	*	**	***	*
Animal	NS	NS	NS	*	NS
Diet x Period	NS	NS	NS	*	NS
Residual standard deviations	1.756	0.284	8.946	0.114	10.13
R-Square	0.413	0.439	0.486	0.737	0.401

[1]C = control diet; D1 = 1.5% palm oil diet; D2 = 3% palm oil diet. Means in the same column with different superscripts significantly differ ($p<0.05$).

partially explain the decrease in milk protein concentration after fat supplementation. No changes were observed in milk minerals concentration following treatment except a significant increase ($p<0.05$) in copper concentration. Few studies have determined milk minerals as a reflection to the fat supplementation in the ration. The increase in copper could be a consequence of changes in the nature of rumen fermentation following fat supplementation. It has been found that polyunsaturated fatty acid concentrations were higher ($p<0.05$) in steers receiving Cu, this confirm the point that copper alters lipid and cholesterol metabolism in ruminants (Engle and Spears, 2000). It can be concluded that supplementing camel rations with palm oil at early stages of lactation, resulted in a decrease in daily feed intake and daily milk production but didn't change the chemical composition of milk. The supplementation of palm oil could enhance milk yield in relation to dry matter intake in she camel only under desert conditions.

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