Minufiya J.Agric.Res.Vol.35 No. 4(1):1285-1295(2010)"http://agri.menofia.edu.eg/megla.html"

MILK PRODUCTION AND COMPOSITION OF COWS AS AFFECTED BY DIETARY PROTECTED FAT SUPPLEMENTATION

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(Received: Mar. 23 , 2010)

ABSTRACT: ***The present experiment was conducted to study the effect of dry-protected-fat supplementation on milk yield and composition of dairy cows. Eighteen dairy Holstein cows were chosen and allocated into 3 experimental groups in a completely randomized block design. The average body weight was 552, 557 and 555 kg, respectively. The protected fat was mixed with wheat bran and cooked by the Extruder machine. Three experimental concentrates were prepared; the control ration was that of concentrate feed mixture (CFM) without adding fat (R0); the second and third concentrates were supplemented with either 3% (R3) or 5% (R5) of the protected fat on DM basis. Results revealed that daily milk yield increased due to the fat supplementation (R3 and R5). The overall average of milk yield was 20.06, 23.66 and 21.13kg/d for R0, R3 and R5, respectively. Milk yield produced by the cows fed R3 increased to reach its peak at week 3 of the experiment and declined thereafter, and being higher than the control (R0); milk yield of R5 showed an intermediate pattern. Milk yield (as 4% fat corrected) followed almost similar trend as the actual milk yield. Milk fat percentage was higher for R3 and R5. The overall average was 3.68, 4.12 and 4% for R0, R3 and R5, respectively. Percentages of milk protein, lactose, total solids and solid not fat did not differ due to the fat supplementation. Total actual 305-d milk yield was 4695, 5820 and 5212kg for R0, R3 and R5, respectively. Fat corrected milk followed the same pattern being higher for R3 (5929kg) than R0 (4481kg); R5 reported an intermediate value (5214kg). The same pattern was found for milk fat and milk protein production being 173.5, 240.8 and 208.5kg for fat and 110.3, 151.4 and 131.6kg for protein in groups R0, R3 and R5, respectively.***

Key words: ***dietary fat, dairy cows, milk yield, milk composition***

INTRODUCTION

Supplementing fat to the diets of dairy cows can help in covering the requirements of energy for high milk yield without causing metabolic disorders that often associated with large intakes of grain (Simas *et al.*, 1997). To increase energy density without the ruminal acidosis and depressing milk fat due to the use of high starch and low fiber diets, attention has been directed to the inclusion of fats and oils in ruminant

rations (Palmquist, 1991; Choi and Palmquist, 1996; Chan *et al.,* 1997; Simas *et al.,* 1997; Zervas *et al*., 1998; Casals *et al*., 1999; Kowalski *et al*., 1999; Offer *et al*., 1999; Zedan 2003).

Addition of fat to the ration of lactating cows increased energy density of the ration and milk production. Despite potential improvements in energy intake and milk yield, additional fat often causes a marked reduction in feed and energy intake when fed to cows in large amounts (Schauff and Clark, 1992 and Christensen *et al*., 1994). Adding fat to dairy diets did not increase milk yield significantly (El-Bedawy *et al*., 1994 and Rodriguez *et al*., 1997). However, many other investigators (Choi and Palmquist, 1996; Flachowsky *et al*., 1996; Abel-Caines *et al*., 1998; Simas *et al*., 1997; Casals *et al*., 1999) found that milk yield increased with dietary fat supplementation. The present study was conducted to study the effect of dry-protected-fat supplementation on milk yield and composition of dairy cows.

MATERIALS AND METHODS

This experiment was carried out in the Animal Production Research Station (Toukh Tanbesha), belonging to Menufiya University. Eighteen dairy Holstein cows were chosen and allocated into a completely randomized block design. Cows were nearly identical in their milk production, lactation season and day in milk (DIM).

In order to achieve accuracy in allocating the cows to the experimental groups, two cows were allocated in each block regarding average milk production (22±0.23 kg/day) and lactation season (each season was represented in the three groups as possible). The similarity was found for milk production (average 22±0.23kg/d); DIM was 77, 68 and 70 for the three groups respectively. Also the average body weight was 552, 557 and 555kg, respectively.

Before the start of the experiment, animals were adapted to the experimental rations for two weeks prior to the data collection. The protected fat had been bought from Alpha Chemistry Company and was mixed with wheat bran and cooked by the Extruder machine in the Unit of Food Research, Faculty of Agriculture, Menufiya University. The final product is bullets of bran carrying the protected fat of about 41.7%. Animals were fed individually according to NRC (1996). Nutrient requirements were adjusted every two weeks according to changes in body weight and milk yield. Three experimental concentrates were prepared as shown in (Table 1). The control ration was that of concentrate feed mixture (CFM) without adding fat; the second and third concentrates were supplemented with either 3% or 5% of the protected fat on DM basis.

The experimental period lasted for 12 weeks, during which three plan of nutrition was applied depending on the availability of the roughage sources. Each plan was applied for approximately 4 weeks. These feeding programs were; 1) The first plan of nutrition consisted of CFM (10kg/head), Berseem

Miskawi (50kg/ head) and corn silage (3kg/ head). 2) The second plan of nutrition consisted of CFM (10kg/head), Berseem Miskawi (31.25kg/ head) and corn silage (11.25 kg/ head). 3) The third plan of nutrition consisted of CFM (10kg/head), Berseem hay (5kg/ head) and corn silage (11.25kg/ head).

Table 1: Composition of the formulated experimental concentrate mixtures

Ingredient	The Experimental concentrate mixtures		
	Control ration R0	3% ration R3(control + adding 3% fat)	5% ration R5(control adding 5%fat)
	%		
Yellow corn	43	43	43
Soybean meal	11	11	11
Cottonseed meal	12.5	12.5	12.5
Untreated wheat bran	24.5	17.4	12.8
Treated wheat bran	---	12.2	20.03
Molasses	5	5	5
NaCl	1	1	1
Limestone	2	2	2
Vitamin mix	0.1	0.1	0.1
Mineral premix	0.1	0.1	0.1
Sodium bicarbonate	0.5	0.5	0.5
Di-calcium phosphate	0.3	0.3	0.3

Animals were housed in three semi-open hangars (a hangar for each group). Animals were fed in the hangar and were moved three times daily for milking parlor. Concentrate mixture was offered twice a day at 7.00 a.m. and 12.00 noon. Berseem was fed at 8.00 a.m. and 7.00 p.m. Corn silage was fed at 12.00 midday. Fresh water was available all the times. Daily milk yield was recorded for each milking for individual cow during the last day of each week. Milk samples were individually collected three times during the last day of each week at 4.00 a.m., 12.00 midday and 6.00 p.m. Milk fat, protein, lactose and total solids were determined in composite samples by Milk-O-Scan at the National Center for Animal Management Training at Sakha, Agriculture Research Center, Ministry of Agriculture. Fat corrected milk (FCM) was calculated according to Gaines (1923) [4%FCM=0.4*(Kg of milk)+15*(Kg of milk*fat%)]

Data of the present study were analyzed using GLM procedure of the SPSS program, version 13 (SPSS, 1997).

RESULTS AND DISCUSSION

Data illustrated in Fig (1) present the average daily milk yield during the whole experimental period. Milk yield increased due to the fat supplementation (R3 and R5), however, differences reached a significant level only at weeks 4, 5 and 10-12. The overall average of milk yield was 20.06, 23.66 and 21.13kg/d for R0, R3 and R5, respectively. Generally, milk yield produced by the cows fed R3 increased to reach its peak at week 3 of the experiment and declined thereafter, and being higher than the control (R0); milk yield of R5 showed an intermediate pattern. When milk yield was plotted on the curve as a trend line, it was obvious that rate of decline in milk yield was faster for R0 and R5 than R3 which was almost parallel to the X axis.

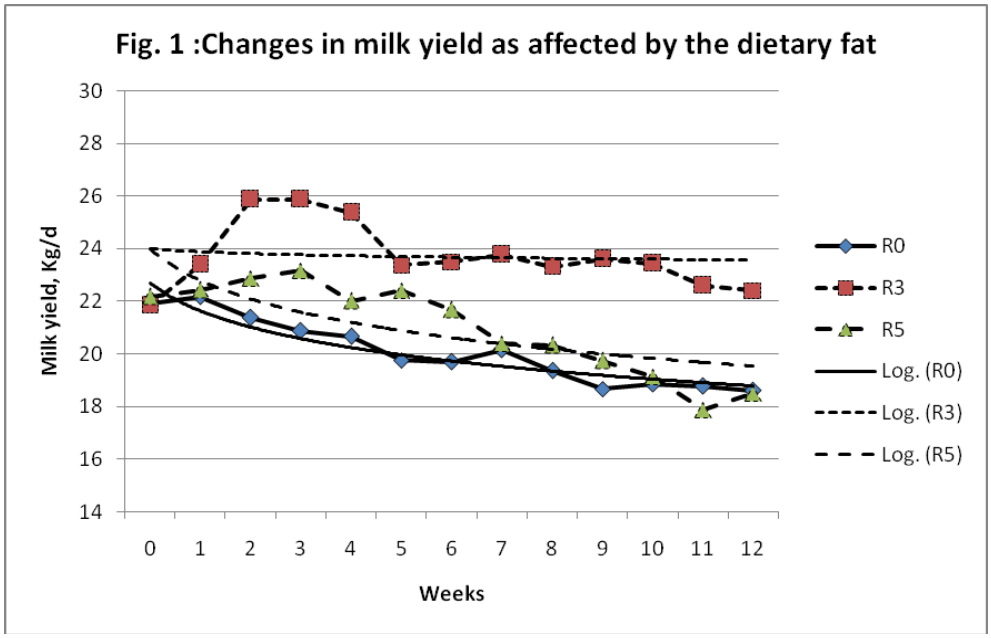

Fig. 1: Changes in milk yield as affected by the dietary fat.

Milk yield was corrected to 4% fat (FCM) and illustrated in Fig (2). It is obvious that FCM followed almost similar trend as the actual milk yield; this was mainly because milk fat was near 4%.

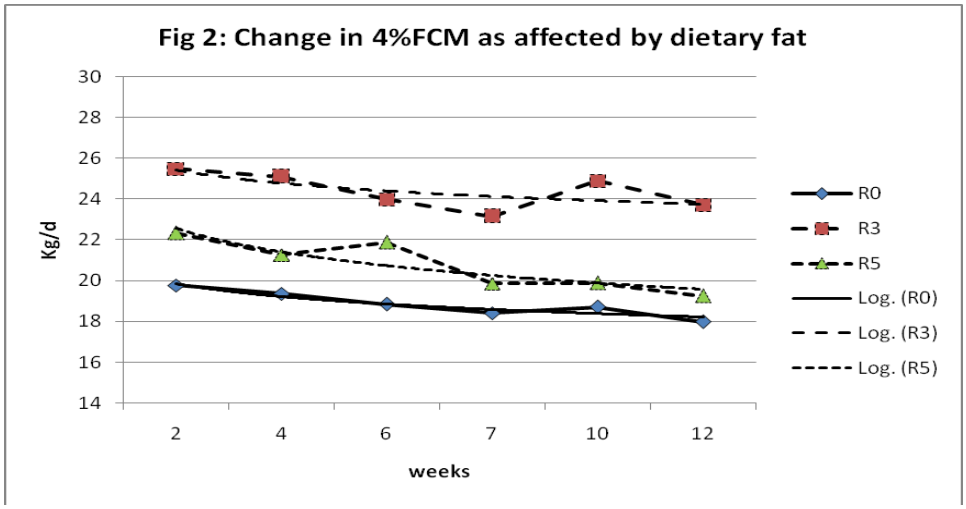

Fig. 2: Change in 4% FCM as affected by the dietary fat.

Schneider *et al.* (1988) observed significant increases in milk yield and 3.5% fat corrected milk when 0.5 kg/d Ca-salts of fatty acids was added to the diet of Holstein cows compared to the control group. Canale *et al*. (1990a and b) tested the effect of adding 0.5 kg/h/d Ca-salts of fatty acids to the diets of Holstein cows on milk yield. Milk yield significantly (P<0.04) increased from 28.7 to 29.8 kg/d and 4% FCM increased from 27.1 to 28.5 kg/d. Jenkins and Jenny (1992) found that milk yield and 4% FCM of Holstein cows increased by adding 10.9% fat to the diet. Sklan *et al*. (1992) observed that milk yield was increased in primiparous and multi-parous cows as a result of adding 2.5% Ca-soaps. Moallem *et al*. (1997) found that actual and 3.5% FCM yields increased by 3.5% and 7.4 kg/d respect for Friesian cows fed diets contained 2.2% Ca-soaps of fatty acids. Dhiman *et al*. (2001) found that Holstein cows receiving fat supplemented diets produced more milk compared with those fed the control diet. Onetti *et al.* (2004) found that milk yield of Holstein cows was increased by increasing the amount of fat in the diet but it was similar for the different fat sources (tallow or Ca-salts of palm oil).

Data in Table (2) present the milk composition as affected by the dietary protected fat supplementation. Fat percentage was higher for R3 and R5. The overall average was 3.68, 4.12 and 4.00% for R0, R3 and R5, respectively. Milk protein percentage did not differ due to the fat supplementation. Average milk protein percentage was 2.47, 2.56 and 2.52 for R0, R3 and R5, respectively. Milk lactose also did not differ due to the fat supplementation. Average milk lactose was 4.24, 4.26 and 4.14% for R0, R3 and R5, respectively. Milk total solids also did not differ due to the fat supplementation. Average milk total solids were 11.08, 11.63 and 11.35% for R0, R3 and R5, respectively. Milk solid-not-fat also did not differ due to the

fat supplementation. Average milk solid not fat were 7.40, 7.51 and 7.35% for R0, R3 and R5, respectively.

Table 2: Average milk composition (%) during the experimental period

Milk Composition	Treatments[(1)]			Sig
	R0	R3	R5	
Fat	3.68[a]±0.15	4.12[b]±0.21	4.00[b]±0.17	0.01
Protein	2.47±0.05	2.56±0.04	2.52±0.07	NS
Lactose	4.24±0.05	4.26±0.11	4.14±0.13	NS
Total solids	11.08±0.15	11.63±0.21	11.35±0.31	NS
Solid-not-fat	7.40±0.05	7.51±0.11	7.35±0.11	NS

[(1)]R0, control ration; R3 and R5 are 3 and 5% fat-supplemented rations, respectively.
[a,b,] means with different superscripts within each row are different.

Total actual 305-d milk yield and 4% FCM as well as milk fat and protein production through the whole milking season are presented in Table (3). Actual milk yield was 4695, 5820 and 5212kg for R0, R3 and R5, respectively. Differences were significant (P<0.05). Fat corrected milk followed the same pattern being higher for R3 (5929kg) than R0 (4481kg); R5 reported an intermediate value (5214kg). The same pattern was found for milk fat and milk protein production being 173.5, 240.8 and 208.5kg for fat and 110.3, 151.4 and 131.6kg for protein in groups R0, R3 and R5, respectively. Differences were significant (P<0.05). The higher fat and protein production was mainly due to the higher milk production.

Table 3: Total milk, FCM*, milk fat and protein production (Kg) during the experimental period

Item	Treatments[(1)]			Sig
	R0	R3	R5	
Total milk	4695[a]±223	5820[b]±288	5212[ab]±411	0.05
FCM*	4481[a]±296	5929[b]±178	5214[a]±365	0.05
Fat	173.5[a]±10.5	240.8[b]±15.3	208.5[ab]±16.5	0.05
Protein	110.3[a]±1.35	151.4[b]±1.21	131.6[b]±1.71	0.05

*FCM, 4% fat corrected milk
[(1)]R0, control ration; R3 and R5 are 3 and 5% fat-supplemented rations, respectively.
[a,b,] means with different superscripts within each row are different.

Murphy and Morgan (1983) showed that milk fat content of Friesian cows was insignificantly higher for cow fed concentrate containing 10.4% protected tallow. Milk protein content was significantly lower (P<0.01) for both tallow supplements than the control (2.93 and 2.96 *vs*. 3.13%). Lactose content was similar for all treatments. Schneider *et al*. (1990) found that milk protein or fat percentage were not significantly affected by feeding Holstein cows diet supplemented with 3.5% Ca-LCFA. Sklan *et al*. (1992) reported that milk lactose concentration was not influenced by dietary treatments. Milk fat percentage and yield were increased for cows fed 2.4% CSFA. Erickson *et al*. (1992) found that milk fat percentage of Holstein cows did not differ when cows were fed a diet contained 3% Ca-LCFA. Wu *et al*. (1993) reported higher fat yield for cows fed fat-supplemented diet than the control (1.11 vs. 1.02 kg/d). However, milk protein yield was not different among the different fat sources. Scott *et al*. (1995) found that milk fat yield and percentage of Holstein cows were not affected by feeding 4.8% Ca-LCFA. Milk protein yield was not significantly affected while milk protein percentage declined (-0.08%, P<0.01) by feeding Ca-LCFA. Lin *et al*. (1996) reported that milk protein of Holstein cows was not affected by feeding a diet contained 1.7kg/d Ca-soaps. Chan *et al*. (1997) found that the percentage and yield of protein, fat, lactose and SNF in milk were not affected by fat addition (7% whole cottonseed or 7% whole cottonseed+ 3% prilled fatty acids) to the diets of Holstein cows. Moallem *et al*. (1997) found that milk fat and protein yield increased by addition of Ca-soaps of fatty acids (CSFA) to Holstein cow's diet. Gontheir *et al*. (2005) reported that addition of 12.7% flaxseeds had no effect on percentage of milk fat, protein and lactose.

From the results obtained in the present study, it could be concluded that adding dietary protected fat at the level of 3% is recommended as a feed additive for dairy cows in order to improve milk production and milk composition without any adverse effect on the productive performance or the animal health.

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تأثير إضافة الدهن المحمي إلى العليقة على إنتاج اللبن و تركيبه في الأبقار

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الملخص العربي

أجريتْ التجربة الحالية لدِراسَة تأثيرِ إضافة الدهنِ الجافِ المحميِ إلى علائق حيوانات اللبن على إنتاج اللبن وتركيبِه. استخدم في الدراسة عدد ثمانية عشرَ من أبقار أللبن. إختيرتْ الأبقار وقسمت إلى ٣ مجموعاتِ تجريبيةِ متماثلة في تصميم القطاعات العشوائيةِ الكاملة. كان متوسط وزن الجسمِ للمجموعات الثلاثة ٥٥٢، ٥٥٧ و٥٥٥ كيلوجرام، على التوالي. تم أقلمة الحيوانات على العلائق التجريبيةِ لمدة إسبوعين قبل جمعِ البياناتَ. تم خلط الدهن المحمي بالنخالةِ وطَبخَ بماكنةِ الطاردَ. تم تكوين ثلاثة خلطات من العلف المركزِ التجريبيِ؛ مجموعة المقارنة تكونت مِنْ خَلِيْطِ من العلف المركزِ بدون إضافة دهنِ (مج صفر)؛ اما المخاليط الثاني والثالث كَانَ عبارة عن المخلوط الأول مضافا إليه ٣ % أَو ٥ % من الدهنِ المحميِ على أساس المادة الجافة. غُذّيتْ كُلّ الأبقارعلى أساس وزنِ الجسمِ ومحصول اللبن ونسبة الدهنِ باللبن. تم تنفيذ ثلاثة تجارب هضم أثناء مراحل الحليب الثلاثة. أوضحت نَتائِج الدراسة ارتفاع محصولَ اللبن اليوميً بسبب إضافة الدهن المحمي (مج ٣ و٥). كان المتوسط العامّ لمحصولِ اللبن ٢٠,٠٦، ٢٣,٦٦ و٢١,١٣ كيلوجرام/اليوم للمجموعات التجريبية الثلاثة (مج صفر، مج٣ و مج ٥) على التوالي. محصول اللبن المعدل لـ ٤ % دهن تبع إتجاهَ مماثلَ تقريباً كمحصول اللبن الفعلي. كَانتْ نسبة دهن اللبن المئوية أعلى للمجوعات مج ٣ ومج ٥. وكان المتوسط العام ٣,٦٨، ٤,١٢ و٤ % للمجموعات الثلاثة، على التوالي. النِسَب المئوية لكل مِنْ بروتينِ اللبن، اللاكتوز، المواد الصلبة الكليّة والمواد الصلبة غير الدهنية لَمْ تختلفْ بسبب المعاملة الدهنية. كَانَ محصول اللبن الفعلي الكليّ في ٣٠٥يوم ٤٦٩٥ و ٥٨٢٠ و٥٢١٢ كيلوجرام للمجموعات صفر، ٣ و٥%، على التوالي. محصول اللبن المعدل لنسبة دهن ٤% اتخذ نفس النمطِ حيث كان أعلى في مج ٣ (٥٩٢٩ كيلوجرام) عن مج صفر(٤٤٨١ كيلوجرام)؛ بينما سجلت مج٥ قيمةِ متوسّطةِ (٥٢١٤ كيلوجرام). تبع كل من دهن وبروتين اللبن نفس النمطِ حيث وُجِدَ أن أنتاج دهنِ اللبن وإنتاجِ بروتينِ اللبن كان ١٧٣,٥، ٢٤٠,٨ و٢٠٨,٥ كيلوجرام للدهنِ و١١٠,٣، ١٥١,٤ و١٣١,٦ كيلوجرام للبروتينِ في المجموعاتِ صفر، ٣ و٥%، على التوالي.