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FULL FAT SUNFLOWER SEEDS OR OIL AS FAT SUPPLEMENT FOR DAIRY COWS

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SUMMARY

In switch back 3x3 complete design, six cows were fed control ration (no fat supplement), full fat sunflower seeds (FFS) ration and sunflower oil plus sunflower seed meal (SOM) ration. Feeding FFS or SOM rations increased ($P<0.05$) the digestibility of EE but had no significant effect on the other nutrient digestibilities. Ruminal pH, total and individual VFA's concentrations were not affected by the dietary treatments. However, feeding fat supplemented rations increased ruminal ammonia. Fat corrected daily milk yield and milk fat percentage increased by feeding fat supplemented rations. Feeding FFS or SOM rations decreased the percentage of short and medium-chain (C8:0 to C16:0) and saturated fatty acids but increased the percentage of unsaturated and C18 fatty acids (18:0 to 18:2). Milk casein nitrogen and non protein nitrogen decreased but whey nitrogen increased by feeding whole sunflower seeds. Blood serum total lipids, cholesterol and triglycrides increased by feeding fat supplemented rations especially sunflower oil plus meal.

Keywords: Dietary fat, lactating cows, sunflower seed, nutrient utilization, milk production, serum lipids

INTRODUCTION

Research has attempted to increase energy intake

thereby improve the energy status of cows by fat supplement into the dairy rations. The results varied and have been influenced by the methods of feeding, types and amount of fats. The National research Council (NRC, 1989) indicated that fat supplement usually does not alter milk production, but milk fat content and composition may be changed. Although most experiments on lipid supplement have been concerned with the protected animal and vegetable fats, information is limited about the response of dairy cows to feeding full fat seeds, particularly whole sunflower seed which contains 35 to 40% oil and 17 to 20% protein (Rafalowski and Park, 1982).

This study was conducted to evaluate the production response of cows to feeding full fat sunflower seed in comparison with feeding sunflower oil plus meal. The comparison was made to know if oil in whole sunflower seed is encapsulated by the seed coat which could alter rate of rumen bypass or release of oil into the rumen.

MATERIALS AND METHODS

Six multiparous Friesian cows were fed complete mixed diets containing no supplementary fat (Control), 1.5 Kg full fat sunflower seeds (FFS) and 0.5 Kg sunflower oil plus 1.0 Kg sunflower seed meal (SOM) in two block 3x3 switch-back complete design (Lucas 1956). The control ration composed of 8.0 Kg common concentrate mixture, 3.0 kg berseem hay and 4 Kg rice straw.

Cows were milked twice daily and milk yields were recorded at each milking throughout each entire experimental period of 30 days (21 days preliminary and 7 days collection periods followed by 2 days for rumen and blood sampling). Milk samples were collected only throughout the collection period from day 22 to 28). Composite milk samples were analyzed for fat, protein, lactose, total solids and solids not fat using Milko-Scan 133 B, Foss Electric. Methyl ester of fatty acid of milk lipids were analyzed (Stahl, 1967) using Gas liquid chrmatography (Hewlett Pakard model 5890). Milk nitrogen fractions were determined according to Rowland (1938).

Fecal samples were collected during the entire collection period (7 days) twice daily at 9.00 and 21.30. Nutrient digestibilities were estimated by Acid-

Insoluble Ash (AIA) method (Van Keulen and Young, 1977). Composite feed and fecal samples were analyzed according to A.O.A.C. (1984) and Goering and Van Soest (1970).

Rumen fluid samples were collected before and 4 hrs post-feeding for two consecutive days (day 28 and 29) of each period via stomach tube. Rumen fluid samples were analyzed for ammonia-N (Conway, 1963), total VFA's (Kromann et al., 1967) and individual volatile fatty acids by gas chromatography (Erwin et al., 1961). Ruminal pH was measured using pH-meter.

Blood samples were withdrawn at same time of rumen sampling before and 4 hr after feeding from the left jugular vein, centrifuged at 9,000 x g for 20 min, and the serum was frozen for later assay for total lipids(Boehriner Mannheim GmbH Diagnostica), cholesterol (Pointe Scientific Inc.) and triglycerides (BioMerieux laboratory reagents and Instruments). Data of serum lipids were presented as an average of before and 4 hr-post feeding values because sampling effects were insignificant.

Data collected were statistically analyzed according to Lucas (1956). Differences among means with a significant F were separated by Duncans' procedure.

RESULTS AND DISCUSSION

Rations were balanced to contain about 14 % crude protein (CP) and 24 % crude fiber (CF). These values were recommended for dairy cow feeding (NRC, 1989). Ether extract (EE) increased from 2.8 % in the control ration to 6.65 % in full fat sunflower supplemented ration (FFS) and 6.20 % in sunflower oil plus meal supplemented (SOM) ration. Hemicellulose was calculated as NDF-ADF and cellulose as ADF-ADL (Table 1).

Cows were fed three rations, the control ration consisted of 8.00 Kg common concentrate mixture, 3.0 Kg berseem hay and 4 Kg rice straw. One and half Kg full fat sunflower seed was supplemented to the control ration to provide 600 g fat in FFS ration while the control ration was supplemented by 1.5 Kg of a mixture consisting of 500 g sunflower oil plus 1.000 kg sunflower seed meal in SOM ration to provide similar content of fat as FFS ration (600 g/day). The increase in TDN and DCP intake from FFS and SOM rations was related to the increase in dry matter intake (Table 2)

Nutrient Digestibilities and nutritive value of the experimental rations are shown in Table 3. Feeding sunflower seed or sunflower oil and meal supplement had no significant effect on the digestibilities of all nutrients except that of EE. However, fat supplements insignificantly decreased the digestibilities of CF and NFE. Cellulose and consequently ADF were the most affected fiber fraction by fat supplements. Cellulose digestibility decreased from 49% to 45% and ADF decreased from 44 % to 41 % by fat supplements. No obvious differences in the nutrient digestibilities between FFS and SOM rations were detected.

Table 1. Chemical composition of the experimental rations

Item	Control	FFS	SOM
Proximate analysis, %			
Dry matter	89.74	90.12	89.92
Dry matter composition			
OM	88.45	88.21	88.94
CP	13.58	14.32	14.76
EE	2.82	6.65	6.20
CF	24.48	24.20	24.33
NFE	47.57	43.04	43.65
Ash	11.55	11.79	11.06
Cell wall constituents			
NDF	56.53	54.32	55.62
ADF	34.01	32.75	33.76
Hemicellulose	22.52	21.57	21.89
Cellulose	26.29	25.17	25.85
ADL	7.72	7.58	7.91

Table 2. Daily dry matter intake from the experimental rations

DM intake	Control	FFS	SOM
Kg/H/day	13.46	14.87	14.84
g/Kg $W^{0.75}$	130.8	149.3	147.0
Kg/100 Kg BW	3.85	3.22	3.16

Table 3. Nutrient digestibilities and nutritive values of the experimental rations

Item	Control	FFS	SOM	SE
Apparent digestibilities, %				
DM	63.95	61.75	61.43	3.78
OM	66.39	63.55	63.91	3.87
CP	67.19	68.89	68.26	3.38
EE	74.24b	86.27ab	87.57a	2.92
CF	54.41	48.30	49.15	6.04
NFE	71.87	66.84	67.29	3.63
NDF	52.99	50.75	49.00	4.36
ADF	45.87	41.96	41.58	5.24
Hemicellulose	63.72	64.11	60.47	3.38
Cellulose	49.38	45.53	45.28	4.58
Nutritive value, %				
TDN	61.40	63.17	63.65	3.61
SV	46.58	46.34	47.29	3.96
DCP	9.19	9.85	10.09	0.59

[a, b] Means on the same line with different superscripts differ ($P<0.05$).

The higher ($P<0.05$) digstibility of EE associated with fat supplement in FFS and SOM rations might be related to the high digestibility of the supplementary fat (Palmquist and Conrad 1978). In the present study, digestibility of EE from the supplementary fats was calculated to be as high as 92.63% for FFS and 98.22% for SOM ration.

Fat supplement had no significant effect on the TDN, SV and DCP percentages of the rations. The experimental rations were therefore considered isocaloric and isonitrogenous (Table 3).

No significant effects of fat supplement on the basic patterns of rumen metabolites (Table 4) were detected except the post-feeding higher ($P<0.05$) ammonia-N concentrations and the lower ($P<0.05$) molar proportions of acetate and acetate: propionate ratio of sunflower oil and meal supplemented ration (SOM). The higher ruminal ammonia-N concentrations by feeding rations supplemented with sunflower seeds (FFS) or oil and meal

The durinal variations in the basic patterns of rumen fermentation could be summarized in lower ruminal pH and molar proportions of acetate, iso-butyrate and isovalerate after feeding. However, ammonia-N, total VFA's concentrations and molar proportions of propionate, butyrate and valerate were higher at 4 hr post-feeding in comparison with the initial values before feeding. The lower acetate and higher propionate resulted in lower acetate: propionate ratio at 4 hr post feeding (Table 4).

Actual and 4%-fat corrected milk (FCM) yeild were not significantly affected by the treatments. However, cows fed FFS and SOM rations produced 0.96 Kg (+13%) and 0.73 Kg (+10%) FCM more than the control (Table 5). This increase in milk yield of cows fed fat supplemented ration was related to the increase in intake of fat and dry matter from fat supplemented rations. Little or no response to fat feeding has been observed in short term switch back or Latin square experiments with few replicates which were conducted near the peak of production or when cows produce less than 30 Kg milk daily (Schingothe and Casper 1991, Palmquist and Conrad, 1978).

Table 5. Milk yield and composition

Item	Control	FFS	SOM	SE
Milk yield, Kg/day				
Actual	8.70	8.54	8.99	1.75
FCM (4% fat)	7.17	8.13	7.90	0.73
Milk composition,%				
Fat	2.83	3.56	3.14	1.78
Protein	2.72	2.85	2.86	0.07
Lactose	4.33	4.55	4.47	0.09
Total solids	10.41	11.53	10.94	0.31
solids not fat	7.58	7.97	7.80	0.06

Feeding full fat sunflower seeds increased milk fat percentage by about 25% while feeding sunflower oil and meal increased it by 11%. This remarkable but not significant increase in milk fat content specially by feeding FFS ration might be due to the high polyunsaturated fatty acids content of sunflower oil

since Palmquist (1988) stated that "the only fat feeding system shown to increase milk fat percentage consistently is the use of polyunsaturated protected lipid supplement". The highest milk fat percent (3.56%) by cows fed FFS ration may refer to that oil in sunflower seed is encapsulated by seed coat (McGuffey and Schingoethe (1982). Feeding fat supplemented rations also increased milk protein, solids not fat and total solids but the differnces were not significant.

Feeding full fat sunflower seed or sunflower oil and meal decreased the percentage of short and medium-chain (C8:0 to C16:0) fatty acids but increased the percentage of C18 fatty acids (18:0 to 18:2). Stearic (C18:0) increased from 16.25 to 23.46% by feeding FFS ration or to 24.35% for SOM ration. The corresponding increase in oleic (C18:1) was from 27.93% to 38.33% for FFS and to 37.83 for SOM ration (Table 6). The decrease in milk short and medium chain fatty acids might be due to the inhibition of their de novo synthesis in the mammary gland as a result of formation of trans isomers formed by the biohydrogenation of long chain fatty acids in the rumen (Teter et al., 1990). However, the increase in milk long chain fatty acids might be due to the increase in trans 18:1 isomers, which is the normal intermediates by ruminal biohydrogenation of linoleic (C18:2) and linolenic (C18:3) of sunflower oil (Grummer,1991).

Table 6. Milk fatty acid composition

Fatty acid1	Control	FFS	SOM
8:0	0.25	0.23	0.13
10:0	2.08	1.10	0.01
12:0	3.08	1.69	1.91
14:0	11.44	7.09	8.32
15:0	1.93	1.37	1.23
16:0	30.30	20.26	20.48
16:1	1.48	1.26	1.18
17:0	1.31	0.92	0.83
17:1	0.40	0.60	0.26
18:0	16.25	23.46	24.35
18:1	27.93	38.33	37.83
18:2	3.32	3.56	3.30
18:3	0.23	0.13	0.18

1 Carbon length: number double bonds.

Feeding full fat sunflower seeds (FFS) decreased casein nitrogen and NPN but increased whey-N of the milk. Moreover, feeding sunflower oil and meal (SOM) increased milk NPN (Table 7). However, the differences were not statistically proven. Milk total nitrogen was not affected by treatments. Comparable changes in nitrogen fraction of milk produced by cows fed protected fat supplemented rations were reported (DePeters et al. 1989, Casper and Schingoethe, 1989 and Dunkley et al., 1977).

Table 7. Nitrogen fractions (g/100 g milk) and nitrogen distribution (% of total-N) of milk.

Item	Control	FFS	SOM	SE
Total-N	0.426	0.443	0.455	0.06
Casein-N	0.311	0.295	0.322	0.02
Whey-N	0.077	0.119	0.086	0.03
Non protein-N	0.038	0.029	0.047	0.01
% Total N				
Casein-N	73.00	66.59	70.69	
Whey-N	18.08	26.86	18.97	
Non protein-N	8.92	6.55	10.34	

Hypotheses were suggested to elucidate the depression in milk nitrogen specially casein nitrogen by added fat as the decrease in bovine somatotropin (Casper and Schingoethe, 1989) or insulin (Palmquist and Moser, 1981) which decrease the uptake of amino acids by mammary gland because the uptake of amino acids by mammary gland is a function of both insulin and bovine somatotropin concentrations working synergistically (Brockman and Laarveld, 1986).

Feeding sunflower oil plus meal increased ($P<0.05$) serum total lipids (TL), cholesterol (Chol) and triglycerides (TG). However, feeding full fat sunflower seeds showed comparable concentrations of serum TL, Chol and TG to the control values (Table 8). The increase of total lipids associated with feeding fat supplemented rations might be due the depression in lipogenic enzyme activities by liver and adipose tissues (Storry, 1981) and feeding long-chain fatty acids induced a shift in the balance from active protomeric to inactive polymeric

forms of acetyl-CoA carboxylase in bovine adipose tissues (Bouman and Davis, 1975).

Table 8. Blood serum lipid concentrations (mg/dl)

Item	Control	FFS	SOM	SE
Total lipids	843b	024ab	1318a	128
Cholesterol	189.9b	207.2b	281.4a	41.5
Triglycerides	14.05ab	13.05b	17.56a	2.05

[a,b] Means on the same line with different superscripts differ ($P<0.05$).

Hypercholestrolemia was reported as a standard response to supplementary lipids (Boila et al. 1993; Drackley and Elliott, 1993). The increase in serum cholesterol might be due to the increase in its intestinal biosynthesis (Nestel et al., 1978) or the increase in lipoprotein to meet the enhanced metabolic needs such as transport and absorption of a large load of circulating total lipids and fatty acids (Bitman et al., 1973 and Sharma et al., 1978).

Serum triglycerides were reported to increase (Depeters et al., 1989) or not affected (Choi and Palmquist 1993) by added fat. The lower serum lipid metabolites by cows fed full fat sunflower seeds in comparison with those fed free sunflower oil plus meal might indicate that feeding full fat sunflower might alter rumen bypass or release of oil into the rumen (Rafalowski and Park, 1982).

The overall response in milk composition and serum lipid concentrations resulting from feeding of sunflower seeds are with general agreement with those from protected fat feeding because oil in sunflower seed is encapsulated by seed coat. Therefore direct inclusion of full fat sunflower seed in dairy ration could eliminate the problems associated with protected fat feeding such as handling, processing cost and limitations in use of chemically treated additives (Rafalowski and Park, 1982). Improving the energy concentration of the rations by added fat to overcome the problem of low productivity of high potential lactating cows like Fresian seemed not promising in the short term experiment. Greater response in milk yield would be expected by feeding fat

supplemented rations to high yielding lactating cows in long term experiments.

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البذور الكاملة أو زيت عباد الشمس كإضافات دهنية فى علائق ماشية اللبن

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فى تجربة مصممة بنظام 3x3 switch back غذيت ست بقرات فريزيان على ثلاث علائق الأولى كنترول (بدون إضافة دهن) و الثانية مضاف اليها بذور عباد الشمس كاملة و الثالثة مضاف اليها زيت و كسب عباد الشمس بما يعادل الدهن والبروتين فى البذرة الكاملة.

أظهرت النتائج أن التغذية على العلائق المضاف اليها دهن سببت زيادة فى معاملات هضم مستخلص الإثير الكلى للعليقة وبدون تأثير معاكس معنوى على هضم المركبات الغذائية الأخرى وأن الإنخفاض معامل هضم الألياف والسيليلوز كان غير معنوى. لم تتأثر درجة حموضة الكرش ولا التركيزات الكلية و المنفردة للأحماض الطيارة بينما زادت تركيزات الأمونيا فى الكرش بالتغذية على العلائق المضاف اليها دهن.

أدت التغذية على العلائق المضاف اليها دهن الى زياده فى إنتاج اللبن المعدل نسبة الدهن كنتيجة لتأثيرها الموجب على نسبة دهن اللبن، كما قللت من نسبة الأحماض القصيره والمتوسط السلسلة (ك ٨:ك ١٦) ونسبة الأحماض الدهنية المشبعة وقللت من نسبة الأحماض الطويلة السلسلة (ك ١٨ : ك ١٨:٢) ونسبة الأحماض الدهنية الغير مشبعة. كما لوحظ إنخفاض فى نيتروجين كازين اللبن و النيتروجين غير البروتينى وزياده فى نيتروجين بروتينات الشرش بالتغذية على البذور الكاملة لعباد الشمس مقارنة بالكنترول أو العليقة المضاف اليها زيت عباد الشمس.

وأظهرت نتائج ليبيدات سيرم الدم أن تركيز الليبيدات الكلية و الجلسريدات الثلاثية و الكوليستيرول يزيد بإضافة الدهن و خاصة بإضافة الزيت عنه عند إضافة البذور الكاملة.