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Short communication: Effect of antioxidant supplementation on milk production, milk fat synthesis, and milk fatty acids in dairy cows when fed a diet designed to cause milk fat depression

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ABSTRACT

This study evaluated the effect of a blend of synthetic antioxidants on the yield of milk and milk components and milk fatty acid composition in dairy cows fed a diet designed to cause milk fat depression (MFD). We hypothesized that supplementing a synthetic antioxidant to diets with a high rumen unsaturated fatty acid load (RUFAL) would decrease the severity of MFD. Sixteen lactating Holstein cows (163 ± 47 d in milk), in a crossover design with two 21-d periods, were fed a corn silage and grass silage-based diet containing 15% distillers grains. The diet contained 34% neutral detergent fiber, 18% crude protein, 26% starch, and 4.3% total fatty acids (dry matter basis). Cows were fed the diet without supplementation (control; CON) or supplemented with 0.02% (dry matter basis) of a synthetic antioxidant (AOX; Agrado Plus, Novus International Inc., St. Charles, MO). Dry matter intake and milk yields were recorded daily. Milk samples were collected at the start of the study for baseline values and the end of each period (d 20–21) and analyzed for milk components and fatty acid composition. Dry matter intake and milk yield were unaffected by treatment and averaged 25.9 and 50.2 kg/d, respectively. Similarly, we observed no effect of treatment on yields of fat, protein, lactose, 3.5% fat-corrected milk, energy-corrected milk, feed efficiency, body weight, or body condition score. Milk fat concentration and yield were both reduced by the high RUFAL diets. We observed a tendency for AOX to increase the concentration of milk fat and decrease the concentration of milk protein. Yields of de novo and preformed fatty acids were not affected by treatment, although we detected a trend for a slight increase in the yield of 16-carbon fatty acid for AOX compared with CON. Treatment had only minor effects on individual milk fatty acids, except for the concentration and yield of linoleic acid, which were over 90% higher for AOX compared with CON. In conclusion, milk fat concentration and yield were reduced by a high RUFAL diet containing 15% distillers grains; however, supplementation with AOX did not overcome the MFD induced by this diet.

Key words: antioxidant, biohydrogenation, unsaturated fatty acid, milk fat

Short Communication

Available evidence indicates that milk fat depression (**MFD**) is caused by shifts in the pathways of rumen biohydrogenation (**BH**) of unsaturated FA and the passage of specific BH intermediates (e.g., *trans*-10,*cis*-12 18:2) out of the rumen that subsequently reduce milk fat synthesis in the mammary gland (Bauman et al., 2011). An increase in rumen unsaturated FA load (**RUFAL**) is a well-established risk factor for MFD (e.g., He et al., 2012). Previous work suggests that a high level of vitamin E (α-tocopheryl acetate) has the potential to maintain "normal" BH pathways, thereby possibly reducing the production of BH intermediates that cause MFD (Focant et al., 1998; Pottier et al., 2006). Results from studies supplementing synthetic antioxidants in dairy cows have been mixed; Vázquez-Añón et al. (2008) reported improvements in milk fat yield when a synthetic antioxidant was supplemented in diets containing 2% soybean oil. However, He and Armentano (2011) supplemented the same synthetic antioxidant and found no effect on DMI, milk yield, or milk components with diets containing 5% vegetable oils varying in their degree of unsaturation. Therefore, our objective was to examine the effect of a blend of synthetic antioxidants, Agrado Plus (Novus International, Inc., St. Charles, MO), on the yields of milk and milk components and milk FA profile in cows fed a high RUFAL diet, containing 15% dried distillers grains (**DDG**). We hypothesized that dietary antioxidant would alleviate the negative effect of the high RUFAL diet and minimize shifts in BH pathways in the rumen,

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Table 1. Ingredient and nutrient composition of the experimental diet

Item	Diet[1]
Ingredient, % of DM	
Corn silage	33.2
Grass silage	13.1
Alfalfa hay	3.5
Corn meal	13.1
Dried distillers grains	15.1
Soybean meal	6.0
Soybean hulls	4.6
Mineral mix[2]	11.4
Nutrient composition	
DM, %	47.7
NDF, % of DM	34.2
Starch, % of DM	25.8
CP, % of DM	17.8
Total FA, % of DM	4.3
FA concentration, g/100 g of total FA	
14:0	0.5
16:0	16.9
16:1 *cis*-9	0.6
18:0	4.8
18:1 *cis*-9	23.6
18:2 *cis*-9,*cis*-12	40.8
18:3 *cis*-9,*cis*-12,*cis*-15	6.1
Σ Others	6.7
RUFAL[3]	70.5

[1]Agrado Plus (Novus International Inc., St. Charles, MO) was added to the AOX diet at 0.02% of DM.

[2]Mineral mix contained 22.7% wheat middlings, 17.5% molasses, 14.0% calcium carbonate, 8.9% beef blood meal, 9.4% sodium bicarbonate, 7.6% partially hydrogenated tallow, 6.3% Amino Plus (Ag Processing Inc., Hastings, NE), 4.7% salt, 3.2% calcium sulfate dihyd, 2.8% urea, 1.7% magnesium oxide, 0.4% Cargill 885 Se 0.06 (Cargill Inc., Minneapolis, MN), 0.3% Alimet (Novus International Inc.), 0.2% Cargill Dairy ADE 5487 (Cargill Inc.), and 0.3% Mintrex R (Novus International Inc.).

[3]Rumen unsaturated fatty acid load.

thereby reducing the formation of MFD-related BH intermediates and decreasing the risk of MFD.

Sixteen lactating Holstein cows (6 primiparous and 10 multiparous), averaging 163 ± 47 DIM, 46.7 ± 1.8 kg/d milk yield, and 3.8 ± 0.01% milk fat at the beginning of the experiment, were used in a crossover design with 2 consecutive 21-d periods. Cows were blocked based on milk yield and milk fat concentration. Cows were housed in tiestalls equipped with individual feed boxes and fed a diet formulated according to NRC (2001) recommendations (Table 1). Water was available ad libitum in each stall. Cows were milked 3 times a day at 8-h intervals.

The high RUFAL diet contained 15% DDG (DM basis; Table 1). Cows were either fed the diet without supplementation (control; **CON**) or supplemented with 0.02% (DM basis) of Agrado Plus (**AOX**). The Agrado Plus was blended into a separate mineral mix for the AOX treatment. Diets were fed once a day (1000 h) for ad libitum intake and feed intake was recorded daily. Individual feed ingredients were analyzed for chemical composition (Cumberland Valley Analytical Services Inc., Hagerstown, MD; Table 1). Body weight and BCS (Wildman et al., 1982) were measured at the end of each period. Dry matter intake and milk yield were recorded daily and milk sampled at each milking on d 20 and 21 of each period. Individual milk samples were analyzed for fat, true protein, and lactose concentrations by mid-infrared spectroscopy (AOAC, 1990; method 972.160) by Dairy One (Ithaca, NY) and for

Table 2. Dry matter intake, milk production, milk components, feed efficiency, BW, and BCS for cows fed treatment diets (n = 16)

	Treatment[1]			
Variable	CON	AOX	SEM	Treatment *P*-value
DMI, kg/d	25.7	26.0	0.50	0.49
Milk yield, kg/d				
Milk	50.2	50.2	1.28	0.96
3.5% FCM[2]	48.0	48.9	1.20	0.34
ECM[3]	48.1	48.6	1.15	0.53
Milk components				
Fat, kg/d	1.62	1.68	0.05	0.18
Fat, %	3.27	3.39	0.09	0.07
Protein, kg/d	1.48	1.46	0.04	0.37
Protein, %	2.95	2.91	0.04	0.06
Lactose, kg/d	2.48	2.49	0.06	0.81
Lactose, %	4.95	4.98	0.04	0.25
Feed efficiency (ECM/DMI)	1.88	1.87	0.03	0.82
BW, kg	688	692	17.4	0.16
BCS	3.12	3.10	0.08	0.61

[1]Treatments were high rumen unsaturated FA load diets containing 15% dried distillers grains either without supplementation (CON) or supplemented with a synthetic antioxidant (AOX; Agrado Plus, Novus International Inc., St. Charles, MO) at 0.02% of diet DM.

[2]3.5% FCM = [(0.4324 × kg of milk) + (16.216 × kg of milk fat)].

[3]ECM = [(0.327 × kg of milk) + (12.95 × kg of milk fat) + (7.20 × kg of milk protein)] (Tyrrell and Reid, 1965).