Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 2 *Dairy Research (1984-2014)*

Article 369

1994

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INFLUENCE OF SOURCE OF CALORIES ON COMPOSITION AND PRODUCTION OF MILK

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Summary

Wheat and tallow increased milk production in a complementary fashion when added to a milo-based grain mix.

(Key Words: Concentrate Mixes, Tallow, Wheat, Milo, Milk Yield.)

Introduction

Feeding to achieve near maximum function of the rumen microbial population is the first criterion that must be met to achieve maximum production from the dairy cow. Diets should contain sufficient rumen-soluble carbohydrates and protein to fulfill requirements of the rumen microbes.

In an earlier study (KAES Report of Progress 608:19), cows fed a low rumen-soluble carbohydrate (milo) produced 71.3 kg of milk daily containing 3.49% fat and 3.0% protein and exhibited a plasma urea nitrogen (PUN) level of 6.98 mM. When dietary rumen-soluble carbohydrate was increased by substituting wheat for 30% of the milo, and calorie and protein intake were held constant by the amount fed, milk output increased by 3%, milk fat percentage decreased (3.49 vs 3.36%), and milk protein and PUN percentage remained constant. When dietary rumen soluble carbohydrate was decreased by substituting fat (fancy white tallow) for a portion of the milo (equal caloric basis), milk output increased by 14%, milk fat and protein percentage remained constant, and PUN tended to increase (6.98 vs 6.68 mM).

These data suggest that a deficit of rumen-soluble carbohydrate in the milo diet reduced rumen microbial activity because PUN was decreased when wheat was substituted into the diet. However, this did not have a major effect on milk output.

The increase in milk output realized from the substitution of fat calories for carbohydrate calories suggests that dietary fat is utilized more efficiently or has a positive impact on nutrient supply to the mammary gland apart from its caloric contribution. The combined data indicate that an increase in soluble carbohydrate simultaneously with the addition of fat might have an additive effect on milk output if, in fact, soluble carbohydrates stimulate rumen microbial activity and dietary fat enhances metabolic activity in favor of the mammary gland.

Procedures

Thirty-two Holstein cows averaging 90 days in milk were assigned randomly to four treatments. Treatments were balanced by pretrial milk yield, days in milk, and parity. A four by four Latin Square with 28-day periods was utilized to evaluate treatment effects. Treatments were: sorghum-milo base grain mix (S); 2) 70% sorghum-milo + 30% wheat base mix (SW); 3) sorghum-milo mix + tallow (ST); and 4) 70% sorghum-milo + 30% wheat base mix + tallow (SWT). One lb of tallow per head per day was substituted in diets on an equal caloric basis. Chopped alfalfa hay was the only forage in all diets. Diets were formulated in accordance with NRC recommendations to support a 1400 lb cow producing 80 lb of 4.0% fat, 3.2% protein milk. All cows were fed a total mixed ration twice daily (40% in A.M., 60% in P.M.).

Results

Results of this study are presented in Tables 1 and 2. In essence, the effects of increasing rumen-soluble carbohydrate and dietary fat simultaneously equals the single effect of increasing rumen soluble carbohydrate plus the single effect of increasing dietary fat relative to milk output. This complementary effect can be illustrated by utilizing the formula [(SW-S) + (ST-S)] = SWT - S, where S, SW, ST, and SWT represent milk yields (lb/cow/day) from the experimental diets:

[(SW – S) + (ST – S)] = SWT – S
[(66.44 – 64.24) + (68.64 – 64.24)]
= 70.62 – 64.24
2.2 + 4.4 = 6.38
6.6 = 6.4

The substitution of fat into the milo diet (ST) depressed (P<.05) milk protein relative to the milo:wheat diet. Average daily lb of milk protein was lowest for cows fed the S diet (2.07 lb), similar for cows fed the SW (2.16 lb) and ST (2.17 lb) diets, and highest for cows fed the SWT diet (2.25 lb). Average daily lb of milk fat was lowest for the S (2.4 lb) and SW (2.4 lb) diets, slightly higher for cows fed the ST (2.51 lb) diet, and highest for cows fed the SWT diet (2.58 lb). Increasing rumen-soluble carbohydrate reduced (P<.05) PUN in the cows fed the SW diet, whereas the substitution of fat increased PUN relative to the basal milo diet. Simultaneous inclusion of fat and increase in rumen-soluble carbohydrate resulted in a PUN value similar to that of the basal diet of milo.

Conclusions

These data tend to support the concept that rumen-soluble carbohydrates have a direct positive effect on rumen microbial activity, whereas dietary fat alters metabolic activity in favor of milk synthesis. It has been hypothesized that the substitution of fat calories for carbohydrate calories negatively alters insulin secretion rate via a reduction in propionate production, and thus avoiding an insulin-directed diversion of nutrients from milk synthesis to synthesis of body tissue.

Table 1. Diet Composition (% As Fed)

	Dietary treatments[1]			
Ingredient	S	SW	ST	SWT
Alfalfa hay	44.11	44.72	45.95	46.51
Sorghum grain	43.45	31.03	38.59	27.53
Wheat		13.15		11.66
Tallow			1.62	1.64
Soybean meal	5.21	3.78	6.63	5.39
Distillers grains	3.11	3.15	3.24	3.28
Molasses	1.55	1.59	1.38	1.41
Dicalcium phosphate	.64	.61	.73	.72
Limestone	.43	.47	.42	.44
Bicarbonate	.76	.76	.73	.72
Magnesium oxide	.37	.38	.37	.36
TM salt	.25	.24	.23	.23
Vit ADE	.12	.13	.11	.11

[1]S = sorghum-milo base grain mix; SW = 70% S + 30% wheat; ST = S = 1 lb of tallow; and SWT = S + 30% wheat + 1 lb of tallow.

Table 2. Treatment Effects on Production and Metabolic Traits

	Dietary treatments				
Item	S	SW	ST	SWT	SE
Milk, lb	64.2[a]	66.4[ab]	68.6[bc]	70.6[c]	1.0
4% FCM, lb	61.8[a]	62.0[a]	64.9[ab]	66.9[b]	1.21
Fat, %	3.73	3.61	3.65	3.65	0.08
Protein, %	3.23[ab]	3.25[a]	3.16[b]	3.19[ab]	0.02
Lactose, %	4.79	4.74	4.79	4.81	0.03
SNF, %	8.74	8.72	8.65	8.71	0.05
SCC (×1000)	175.3	139.8	126.3	110.5	27.8
Body wt. (BW), lb	1431	1445	1432	1436	
Change in BW, lb/day	.90	.75	.97	1.19	1.41
Dry matter intake, lb/day	61	60	62	61	
Dry matter intake, % of BW	4.27	4.17	4.36	4.24	
Body condition score	3.07	3.03	3.05	3.04	0.01
Plasma glucose, mM	3.08	3.09	3.03	3.04	0.04
Plasma urea nitrogen (mM)	7.42[ab]	6.99[b]	7.85[a]	7.58[a]	0.15

[1]S = sorghum-milo base grain mix; SW = 70% S + 30% wheat; ST = S = 1 lb of tallow; and SWT = S + 30% wheat + 1 lb of tallow.

[abv]Means within row without a common superscript letter differ (P<.05).