EFFECTS OF FEEDING WHOLE COTTONSEED COATED WITH STARCH, UREA, OR YEAST ON PERFORMANCE OF LACTATING DAIRY COWS

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Introduction

Whole cottonseed (WCS) is commonly used in the rations of lactating dairy cows as a source of energy, fiber, and protein. The high oil content of WCS makes it an attractive energy dense feed for animals with high energy requirements, such as lactating dairy cattle. The high fiber concentrations provided by the lint and the hull are desirable for maintaining effective fiber levels in the diet. However, the lint makes WCS difficult to handle in mechanized feeding systems and limits its use in many commercial feed mills and dairy farms.

Recent work has focused on coating whole cottonseed with gelatinized corn starch to bind the lint and make a free flowing product that improves handling characteristics (Bernard et al., 1999; Laird et al., 1997). However, coating whole cottonseed with 5 % starch reduces fiber digestibility through competitive inhibition between cellulolytic and amylolytic rumen bacteria and consequently reduces milk fat percentage in lactating dairy cows (Bernard et al., 1999). Because cellulolytic microorganisms use ammonia as their primary nitrogen source, the inclusion of urea in the coating may aid in improving fiber digestion. Yeast is a common feed additive that has been shown to increase cellulolytic bacterial numbers (Martin and Nisbet, 1992). The addition of yeast to the starch coating could potentially increase fiber digestion as well. This research examines the effects of the addition of urea or yeast to the gelatinized corn starch coating applied to WCS on nutrient intake and digestibility and on milk yield and composition in lactating dairy cows.

Materials and Methods

Thirty lactating Holstein cows were used in an 8 wk randomized block trial at the Dairy Research Center in Tifton, GA. All cows were trained to eat behind Calan doors before beginning the trial and were individually fed the control diet (Table 1) with uncoated whole cottonseed for the first two weeks which was used as a standardization period. At the end of the standardization period, cows were assigned randomly to one of the three experimental treatments. Treatments included WCS coated with 2.5% gelatinized corn starch (CONTROL); CONTROL plus 0.5% feed grade urea included in the coating (UREA); or control plus 2.0% yeast culture (Diamond V Mills XP Yeast Culture, YEAST). The amount of feed offered and refused were recorded daily. Milk yield was recorded at each milking (2X). Milk samples were collected from two consecutive milkings each week for analysis of composition (Dairy Farmers of America, Knoxville, TN). Samples of WCS and experimental diets were collected three times each week for chemical analysis. Fecal grab samples were collected during week 5 of the

experimental period to determine apparent digestibility using indigestible acid detergent fiber as a marker.

Results and Discussion

The composition of the coated cottonseed treatments (Table 2) was similar except that the crude protein content was slightly higher for those with urea included in the coating. This is consistent with planned differences. Experimental diets contained similar concentrations of nutrients (Table 3).

Dry matter intake, milk yield and composition was similar for cows fed the control cottonseed and those fed cottonseed coated with starch plus urea (Table 4). Energy corrected milk yield (ECM) increased 6.5% and efficiency of milk production (ECM per unit of dry matter intake) increased 5.3% when cows were fed cottonseed coated with starch and urea compared with CONTROL, but the differences were not significantly different (P = 0.16 and P= 0.15, respectively). The increase in ECM was due to higher milk fat yield in cows fed UREA versus CONTROL (3.32 vs. 2.94 lb/d). The percentage of lactose was numerically lower (4.89 vs. 4.77 %) for cows fed UREA cottonseed compared with CONTROL (P = 0.11). Inclusion of yeast culture in the coating tended to decrease (P < 0.10) the percentage of milk protein and solids-not-fat in milk and increased (P < 0.06) the efficiency of milk production, but no differences were observed for milk yield or other milk components.

Nutrient intake and whole tract apparent digestibility data are presented in Table 5. Intake (P < 0.0001) and apparent digestibility of fat (ether extract, P < 0.07) were higher, but the apparent digestibility of dry matter, crude protein and fiber was lower for cows fed UREA compared with CONTROL. Cows fed diets containing YEAST had lower intake of crude protein (P < 0.04), but the apparent digestibility of ADF was higher (P < 0.03) than that observed for cows fed with diets containing the control cottonseed.

The inclusion of urea in the coating of WCS slightly decreased apparent fiber digestibility but improved fat digestibility (P =0.07), which supported higher milk fat yield and thereby increased ECM. The increase in fat digestibility would more than offset the unexpected decrease in NDF and ADF digestibility energetically. Increased fat digestibility could provide for a more direct transfer of fatty acids into the mammary gland to be incorporated into milk fat, supporting the higher milk fat yield observed in the UREA diet.

Volatilization of urea to ammonia during the coating process may have reduced the actual percentage of urea included in the coating and due to the dilution affect reduced the effects of urea on the rumen cellulolytic microorganisms. Improvements to the coating process may decrease volatilization of urea and allow a greater percentage of the product in the coating.

Both urea and yeast coated products improved the efficiency of milk production in lactating dairy cows. This improvement in efficiency would net the producer

approximately $0.60 per cow per day based on a milk price of $12 per 100 lb. of milk testing 3.5% fat and 3.2% milk protein.

References

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Table 1. Ingredient composition of experimental diets.

Ingredient	% of DM
Alfalfa hay	5.93
Corn silage	38.41
Cottonseed	12.60
Brewers grains, wet	11.08
Steam-flaked corn	20.31
Soybean meal	7.70
Concentrate[1]	3.97

[1] Concentrate provided (DM basis): 25.8% CP, 55.2% ash, 8.59% Ca, 1.65% P, 3.58% Mg, 6.99% K, 6.51% Na, 4.04% Cl, 0.22% S, 5.88 ppm Co, 339 ppm Cu, 1,800 ppm Fe, 30 ppm I, 1,038 ppm Mn, 7.5 ppm Se, 990 ppm Zn, 67,640 IU of Vitamin A, 27,050 IU of Vitamin D, and 425 IU of Vitamin D.

Table 2. Chemical composition of cottonseed [1].

	Control	Urea	Yeast
	---------- % ----------		
Dry Matter	94.1 ± 1.3	94.1 ± 1.3	94.1 ± 1.4
	---------- % of DM ----------		
Crude Protein	17.5 ± 0.7	19.3 ± 0.6	17.7 ± 0.9
Neutral Detergent Fiber	50.3 ± 1.8	48.7 ± 2.1	49.4 ± 1.3
Acid Detergent Fiber	35.7 ± 1.2	34.6 ± 0.9	35.2 ± 2.2
Ether Extract	18.4 ± 0.7	18.4 ± 1.1	18.1 ± 1.4
Ash	3.6 ± 0.2	3.3 ± 1.0	3.7 ± 0.2

[1]Values represent mean ?standard deviation.

Table 3. Chemical composition of experimental diets[1].

	Control	Urea	Yeast
	---------- % ----------		
Dry Matter	48.7 ± 1.6	48.3 ± 1.3	48.0 ± 1.7
	---------- % of DM ----------		
Crude Protein	18.0 ± 0.8	18.0 ± 0.8	17.8 ± 0.9
Neutral Detergent Fiber	38.9 ± 1.4	39.1 ± 2.5	38.3 ± 1.6
Acid Detergent Fiber	17.5 ± 1.2	18.0 ± 1.7	17.8 ± 1.0
Ether Extract	4.1 ± 0.5	4.9 ± 0.7	4.6 ± 0.5
Ash	5.9 ± 0.3	5.9 ± 0.1	5.9 ± 0.4

[1]Values represent mean ?standard deviation.

Table 4. Performance of lactating dairy cows fed diets containing whole cottonseed coated with gelatinized corn starch with either yeast culture or urea included in the coating.

					Contrast[1]	
Item	Control	Urea	Yeast	SE	A	B
DMI, lb/d	57.5	57.9	55.7	1.2	0.78	0.31
Milk, lb/d	81.6	81.5	80.6	2.7	0.97	0.79
Fat, %	3.85	4.02	4.10	0.12	0.34	0.14
Fat, lb/d	2.94	3.32	3.28	0.15	0.09	0.13
Protein, %	3.18	3.17	3.09	0.04	0.93	0.06
Protein, lb/d	2.49	2.54	2.47	0.08	0.65	0.86
Lactose, %	4.89	4.77	4.81	0.05	0.11	0.31
Lactose, lb/d	3.85	3.88	3.86	0.15	0.87	0.94
SNF, %	8.97	8.85	8.79	0.63	0.19	0.07
SNF, lb/d	7.05	7.15	7.04	0.25	0.78	0.99
ECM[2], lb/d	81.5	87.2	85.9	2.8	0.16	0.27
MUN[2],mg/dl	9.47	8.89	8.44	0.85	0.61	0.39
Efficiency[3]	1.42	1.51	1.54	0.04	0.15	0.06

[1]A = control versus urea; B = control versus yeast culture.
[2]Energy corrected milk yield adjusted to 3.5% fat and 3.2% protein; Milk urea nitrogen.
[3]Efficiency defines as ECM per unit of dry matter consumed.

Table 5. Nutrient intake and apparent digestibility of lactating dairy cows fed diets containing whole cottonseed coated with gelatinized corn starch with either yeast culture or urea included in the coating.

					Contrast[1]	
Item	Control	Urea	Yeast	SE	A	B
Intake, lb/d						
DM	58.4	56.5	55.5	1.9	0.49	0.30
CP	11.1	10.4	10.0	0.4	0.19	0.04
NDF	22.2	22.6	22.1	0.8	0.71	0.95
ADF	10.0	10.1	10.6	0.4	0.81	0.24
EE	2.1	2.8	2.3	0.1	<0.0001	0.16
Apparent digestibility, %						
DM	62.4	56.6	60.9	1.3	0.005	0.43
CP	67.5	60.4	63.4	1.9	0.01	0.14
NDF	40.5	34.0	40.7	1.4	0.003	0.91
ADF	25.0	17.8	29.8	1.4	0.001	0.03
EE	48.3	64.7	55.1	6.1	0.07	0.44

[1]A = control versus urea; B = control versus yeast culture.