UTILIZATION OF WHOLE COTTONSEED COATED WITH GELATINIZED CORN STARCH OR A BLEND OF MOLASSES AND FERMENTATION BYPRODUCTS

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Introduction

Whole cottonseed provides a unique blend of protein, fat, and fiber which make it ideal for feeding to lactating dairy cows. However, the lint that provides effective fiber in the ration for lactating dairy cows also causes handling problems and decreases bulk density. Coating WCS with gelatinized corn starch bonds the lint to the hull resulting in a flowable product (Laird et al. 1997). The resulting product supports similar amount of milk production as WCS (Bernard, 1999; Moore et al., 1998). However, digestibility of NDF was lower (Bernard et al., 1999) which may account for reduced milk fat percentage in some (Firkins et al., 2002), but not all (Bernard, 1999; Moore et al., 1998) trials.

Ruminal microorganisms that digest cellulose require ammonia as a substrate. We observed improves in ruminal fermentation (Bernard et al., 2001) and ruminal fiber digestion (Bernard et al., 2003) when urea was included in the gelatinized starch coating applied to WCS. We recently examined a coating of molasses and fermentation byproduct which would provide ammonia as well as peptides and amino acids and observed improved in vitro NDF digestibility (Bernard, unpublished data). This trial was conducted to determine the effect feeding WCS coated with two different types of coating on production and feed efficiency of lactating dairy cows.

Materials and Methods

Thirty-nine lactating Holstein cows averaging 164 days in milk were used in an eight-week trial to determine the effects of feeding whole cottonseed (WCS) compared with WCS coated with gelatinized corn starch or with a mixture of molasses and fermentation byproduct. The experimental protocol was approved by the University of Georgia Animal Care and Use Committee. The cows were trained to eat behind electronic gates (American Calan Inc., Northwood, NH) before beginning the trial. The trial consisted of a two-week preliminary period during which all cows were fed the herd ration and data collected to use as a covariate in the statistical analysis. At the end of the preliminary period, cows were assigned randomly to one of three experimental diets.

Treatments in the trial consisted of WCS or WCS coated with either 2.5% gelatinized corn starch (ST) or a mixture of molasses and fermentation byproduct (MF). The MF coating provided a rapidly soluble carbohydrate source as will as peptides and amino acids. All test products were included in the experimental diets to provide 12% of the ration dry matter (Table 1). Samples of all ingredients were collected three times each

week for analysis of dry matter content (DM) and rations adjusted as necessary for any changes in DM content of ingredients. Experimental diets were mixed and fed once daily in amounts to provide 5% refusal.

Cows were milked twice daily at 0300 and 1600 h. Milk yield was recorded electronically (Alfa Laval Agri., Inc., Kansas City, MO) at each milking and yield averaged by week. Milk samples were collected at two consecutive milking each week and shipped to Dairy Farmers of America, Inc. laboratory (Knoxville, TN) for analysis of percentage milk fat and protein. Once each week, the body weight of each cow was recorded immediately after the 1600 h milking. To reduce variation, water was withheld after milking until cows had been weighed. Samples of dietary ingredients, experimental diets, and orts were collected three times each week and equal amounts combine to form a weekly composite. These samples are currently being analyzed for concentrations of DM, ash, crude protein, fat (AOAC, 1990), ADF, and NDF (Van Soest et al., 1991).

Data from weeks 2 through 6 of the experimental period were subjected to covariate analyses using PROC MIXED producers of SAS (1989). The model included covariate, treatment, week, and the interaction of treatment and week. Cow within treatment was included as a random variable and week was a repeated measure. Orthogonal contrast statements were used to compare WCS versus ST and WCS versus MF. Two cows did not complete the trial because of chronic mastitis and poor performance and their data were not included in the analyses.

Results and Discussion

Dry matter intake and performance results are summarized in Table 2. No differences were observed among treatments in DMI although DMI was numerically higher for MF compared with WCS ($P < 0.15$). Milk yield and composition was similar for all treatments and averaged 78.6 lb./d milk, 3.80 % fat, and 3.01 % protein. No differences were observed in dairy efficiency (ECM/DMI). Initial body weight of cows was similar (1332 lb.) between treatments. Cows gained an average of 118 lb. during the trial. No differences in intake, milk yield or composition were observed between primiparous and multiparous cows.

These results are similar to those previously reported when WCS coated with gelatinized corn starch were included in diets fed to lactating dairy cows (Bernard, 1999; Moore et al., 1998). In contrast to the observations of Firkins et al. (2002), inclusion of ST did not decrease milk fat percentage. The MF coating is palatable based on intake measured during the trial. The MF also supported similar milk yield and composition as either WCS or ST. No differences were observed in the conversion of DM consumed into ECM. This in contrast with the results of previous work in our laboratory in which an increase in efficiency was observed for cows fed WCS coated with starch plus either 0.5% urea or 2.0% yeast culture (Cooke and Bernard, 2005). The body weight gain is higher than normally expected. There were a higher proportion of primiparous cows (24) compared to multiparous cows (14) that would be expected to gain more than multiparous cows.

Results of this trial indicate that coating WCS with 2.5% gelatinized corn starch or a mixture of molasses and fermentation byproduct supports' similar performance and composition as WCS. The coatings do improve handling characteristics which will facilitate shipment to areas outside of the cotton producing area and use in feed mills not equipped to handle WCS.

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Table 1. Composition of experimental diets containing whole cottonseed, or whole cottonseed coated with either 2.5% gelatinized corn starch or a mixture of molasses and fermentation byproducts.

Ingredient	% of DM
Alfalfa hay	8.38
Corn silage	36.93
Steam flaked corn	18.60
Cottonseed	12.00
Brewers grains	11.08
Concentrate[1]	13.00
Composition[2]	
Crude protein	17.10
Undegradable protein	7.20
ADF	20.45
NDF	28.00
Starch	27.02
NE_l, Mcal/lb	0.77

[1]Concentrate contained (DM basis): 39.0 % CP; 0.95 Mcal/lb NE_l; 2.9 % ADF; 5.0 % NDF; 15.4 % fat; 3.39 % Ca; 0.60 % P; 1.32 % Mg; 2.88 % K; 123 ppm Cu; 2.56 ppm Se; 22,300 IU Vitamin A; 8,890 IU Vitamin D; and 111 IU Vitamin E.
[2]Composition based on formulations.

Table 2. Dry matter intake, milk yield and composition of Holstein cows fed diets containing whole cottonseed, or whole cottonseed coated with either 2.5% gelatinized corn starch (ST) or a mixture of molasses and fermentation byproducts (MF).

	Treatments			
	WCS	ST	MF	SE
DMI, lb/d	48.8	49.2	51.3	1.2
Milk, lb/d	79.0	80.1	80.1	1.5
Fat, %	3.88	3.84	3.74	0.12
Fat, lb/d	3.07	3.08	3.00	0.10
Protein, %	3.02	2.99	3.02	0.04
Protein, lb/d	2.39	2.39	2.42	0.05
ECM[1]	81.9	82.4	81.6	1.8
EFF[2]	1.68	1.67	1.59	0.05

[1]Energy corrected milk yield
[2]Efficiency of milk production, ECM/ DMI.