RUMINAL BYPASS OF COTTONSEED MEAL PROTEIN BY LACTATING DAIRY COWS

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Story in Brief

The effect of commercial oil extraction technique (direct solvent extraction, DS; prepress solvent extraction, PP; screwpress, SP) on ruminal protein bypass of cottonseed meal (CSM) was measured in five duodenally cannulated lactating dairy cows fed 60 percent concentrate diets at 3.1 percent of body weight (dry matter). Ruminal bypass of supplemental nitrogen was higher ($P<.05$) for SP than other processing methods (SP 57.0 vs. DS 34.7, PP 35.3) and soybean meal (35.0 percent). Organic matter and starch digestion also were lower ($P<.05$) in the rumen with SP as compared with DS, PP and soybean meal.

Introduction

The amount of undegraded but digestible protein reaching the small intestine of ruminant animals may be inadequate for maximum performance of ruminant animals requiring large amounts of nitrogen. Certain feedstuff processing methods may influence the extent of ruminal protein escape. Three processed forms of CSM are presently available commercially. These are direct solvent, prepress and screwpress meals.

In vivo protein bypass of DS and SP were 24 and 61 percent for steers fed 60 percent concentrate diets at feed intakes of 1.7 and 2.3 percent of body weight, respectively (Zinn et al., 1981). Zinn and Owens (1983) observed ruminal bypass estimates of 43 and 50 percent for DS in steers fed at 1.8 percent of body weight. Little information is available concerning protein bypass at very high feed intakes. Therefore, the objective of this study was to quantitate ruminal protein bypass or escape of protein from DS, PP, SP and soybean meal (SBM) with lactating dairy cows fed near ad libitum feed intake.

Experimental Procedures

Five mature lactating dairy cows (1020 lb) in mid- to late-lactation were fitted with T-type duodenal cannulas and used in a 5x5 Latin square experiment. Ad libitum feed intake was determined in a ten-day preliminary period. Intake was restricted to 90 percent of ad libitum intake during this experiment. Equal amounts of a completely mixed diet (Table 1) were offered three times per day. A negative control diet (NC) without natural protein supplementation was used. Other diets contained CSM and SBM to provide approximately 17 percent crude protein (DS, PP, SP and SBM). Ether extract content of the concentrate portion of the diets was 5.8, 3.8, 6.4, 4.0 and 3.8 percent for DS, PP, SP, SB and NC treatments, respectively. Chromic oxide was included as an indigestible marker. Feed, duodenal and fecal samples were obtained and subjected to all or part of the following analyses:

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Table 1. Diet compositions.

Ingredient, % of DM	Diet		
	CSM	SBM	NC
Cottonseed meal (DS, PP, or SP)	14.6	0	0
Soybean meal	0	11.7	0
Corn starch	0	2.9	13.8
Corn, dry rolled	41.9	41.9	41.9
Prairie hay, chopped	20.0	20.0	20.0
Alfalfa hay, chopped	20.0	20.0	20.0
Molasses, cane	2.0	2.0	2.0
Urea	0	0	.8
Salt, trace mineralized	.2	.2	.2
Limestone	.3	.3	.3
Dicalcium phosphate	.8	.8	.8
Chromic oxide	.2	.2	.2

dry matter (DM), ash, nitrogen (N), acid detergent fiber (ADF), starch, chromium, nucleic acid-N and ammonia-N. Ruminal bypass of supplemental N was calculated as the difference between duodenal flow of feed N between the test diet versus the NC diet.

Results and Discussion

Daily DM intake averaged 31.4 lb per day (3.1 percent of body weight). Ruminal organic matter (OM) digestion (Table 2) was lowest ($P<.05$) for the SP treatment. Postruminal OM disappearance was greater ($P<.05$) for SP than for DS, PP and SBM, so that total tract digestibility did not differ among diets. Starch digestibilities followed a similar pattern and accounted for much of the treatment differences in OM digestion. With the high dietary protein levels in the supplemented diets it is unlikely that ruminal ammonia-N levels limited microbial degradation of protein. Total tract starch digestion was lowest for the NC diet ($P<.05$). This is surprising since corn starch supplied 13.8 percent of the DM of this diet, more than in the other diets, and corn starch should be more digestible than starch from corn grain.

The DS diet had the lowest ($P<.05$) total tract ADF digestibility (Table 2). The lower ADF content of the NC diet may have been partially responsible for its greater digestibility. Ruminal ADF disappearance was similar to total tract digestion suggesting that little fiber was fermented postruminally with any treatment. With high feed intakes and rapid passage rates this appears reasonable. Preferential microbial starch degradation and fast passage rate may have increased lag time for fiber digestion and could be responsible for the low ruminal disappearance of ADF with all diets.

Efficiency of microbial growth was drastically lower ($P<.05$) with the NC diet. Although not measured, ruminal ammonia-N may have been lowest in NC cows due to the lower protein level of that diet (12 percent). Low dietary protein levels and ruminal protein degradation

Table 2. Site and extent of digestion at various sites.

Item	Diet				
	DS	PP	SP	SBM	NC
Organic matter, %					
Ruminal	57.9[a]	57.1[a]	48.3[b]	61.3[a]	58.9[a]
Postruminal	8.3[a]	12.6[a]	20.2[b]	10.8[a]	13.5[ab]
Total tract	66.1	59.7	68.6	72.1	72.4
Starch, %					
Ruminal	68.5[a]	66.6[a]	50.9[b]	68.3[a]	64.5[ab]
Postruminal	27.7[a]	29.1[a]	45.4[b]	28.5[a]	26.9[a]
Total tract	96.2[a]	95.7[a]	96.3[a]	96.8[a]	91.4[b]
Fiber, acid detergent, %					
Ruminal	41.6[a]	45.0[a]	42.7[a]	50.4[b]	52.0[b]
Total tract	36.6[a]	47.4[bc]	46.1[a]	46.0[b]	54.0[d]
Microbial efficiency, g MN/k organic matter fermented	21.8[ab]	18.5[a]	23.0[b]	19.6[ab]	10.8[c]
Ruminal bypass of supplemental protein, % of intake	34.7[a]	35.3[a]	57.0[b]	35.0[a]	--
N, % digested in total tract	64.8[a]	68.2[bc]	67.3[ab]	69.9[c]	69.2[bc]

[a,b,c,d]Means in a row with different superscripts differ(P<.05).

may have produced suboptimal ruminal concentrations of ammonia N and(or) byproducts of amino acid degradation and in this manner reduced efficiency of microbial growth. Microbial efficiency was greater (P<.05) with the SP than with the PP diet, possibly due to differences in ruminal OM digestion. Ruminal bypass of supplemental N was greater (P<.05) for SP than for DS, PP and SBM (57.0 vs 34.7, 35.3 and 35.0 percent) indicating that processing of cottonseed meal can alter bypass considerably. In a similar study with steers fed higher concentrate diets, protein bypass estimates did not differ between CSM type (Goetsch et al., 1984). Differences between trials in intake level may have been responsible for the different protein bypass estimates. However, different associative effects between diet type (i.e., roughage level and type) and ruminal protein degradation could also have been involved.

Literature Cited

Goetsch, A.L. et al. 1984. Okla Agr. Exp. Sta. Res. Rep. MP-116.
Zinn, R. A. et al. 1981. J. Anim. Sci. 52:857.
Zinn, R. A. and F. N. Owens. 1983. J. Anim. Sci. 56:707.