BYPASS OF COTTONSEED MEAL PROTEIN IN STEERS FED HIGH CONCENTRATE DIETS

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Story in Brief

The effect of commercial processing method (direct solvent extraction, DS; prepress solvent extraction, PP; screwpress, SP) on laboratory measurements, in situ rate of nitrogen (N) disappearance, and ruminal protein bypass of cottonseed meal (CSM) was measured. Solubility of N in .15M NaCl of SP CSM (14.7 percent) was about 50 percent of DS and PP (28.8 and 27.4 percent). Nitrogen disappearance after 4 hr of rumen incubation and rate of disappearance from 4 to 12 and from 12 to 20 hr tended to be greater for SBM than for any CSM in steers receiving a high concentrate diet. Digestion of organic matter, starch and fiber in the rumen tended to be less while postruminal digestion was greater for SP than with DS and PP. Ruminal bypass of CSM N in steers fed a high concentrate diet did not differ with processing method (DS 27.2; PP 31.7; SP 33.0 percent).

Introduction

Commercially, the oil in cottonseeds is extracted by one of three processes: 1) direct solvent extraction, 2) prepress solvent extraction and 3) screwpress or expeller. The meal remaining after oil removal could differ in extent of ruminal digestion due to different degrees of exposure to heat and pressure. Incubation studies in vitro have indicated that DS possesses a larger protein fraction with a faster rate of degradation and a lesser amount of a more slowly degraded fraction than SP (Broderick and Craig, 1980). At present, protein bypass of PP has not been estimated and values for other processes are limited. Therefore, the objectives of this study were to quantitate ruminal bypass of protein from DS, PP and SP with steers fed an 80 percent concentrate diet at 1.8 percent of body weight.

Experimental Procedure

Laboratory and In Situ Analyses

Kjeldahl N, ether extract (EE), N solubility (.15 M NaCl) and pepsin indigestible N (PIN) content of each CSM and soybean meal (SBM) were determined (Table 1). Nitrogen disappearance from dacron bags suspended in rumen of steers fed an 80 percent concentrate diet was measured for each supplement. Residual N at 12 hr (percent of 4 hr residual values) and at 20 hr (percent of 12 hr residual values) were regressed against times to calculate rate of N disappearance.

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Table 1. Composition and properties of protein sources.

Item	Protein Source Diet DS	PP	SP	SBM
Ether extract, % of DM	1.7	1.4	5.2	3.3
Total N, % of DM	7.1	7.5	7.1	7.7
Soluble N, % of total N	28.8	27.4	14.7	43.5
Pepsin insoluble N, % of total N	14.1	16.2	19.9	4.2
N disappearance in situ:				
4 h, % of initial N	21.9	30.3	29.6	38.6
4 to 12 h, %/h	1.97	1.98	1.01	2.16
12 to 20 h, %/h	2.61	.95	2.03	6.08

Steer Experiment

Four dairy steers (322 kg), fitted with ruminal and proximal duodenal (T-type) cannulas, were used in a 4x4 latin square experiment. High concentrate diets (80 percent; Table 2) were fed at 1.8 percent of body weight with chromic oxide included as an indigestible marker. A control diet (NC) without protein supplementation was used. In each CSM diet, CSM replaced 15 percent of corn dry matter (DM) in the NC diet. Ruminal, duodenal and fecal samples were taken on the last two days of each 14-day period and subjected to all or part or the following analyses: pH, DM, ash, N, acid detergent fiber (ADF), starch, chromium, nucleic acid-N and ammonia-N. Ruminal bypass estimates of CSM N were calculated as the difference in duodenal flow of feed N between the test diet and NC diet.

Table 2. Diet composition (percentage of dry matter).

Ingredient	Diet CSM	NC
Corn, dry rolled	59.4	74.4
Prairie hay	20.0	20.0
Cottonseed meal (DS, PP, or SP)	15.0	0
Molasses, cane	2.0	2.0
Urea	1.2	1.2
Potassium chloride	.7	.7
Limestone	.6	.6
Salt, trace mineralized	.3	.3
Sodium sulfate	.3	.3
Dicalcium phosphate	.3	.3
Chromic oxide	.2	.2

Results and Discussion

Laboratory and In Situ Analyses

Total N content of PP was slightly greater than for DS and SP (7.5 vs 7.1 percent; Table 1). Soluble N of SP was about half of DS and PP. Soluble N content of the SBM was considerably higher than other reports. Pepsin indigestible N content of CSM samples varied slightly in parallel to the degree of heat treatment and were considerably greater than for SBM. However N disappearance tended to be greater for SBM than for all types of CSM. In situ N loss for PP and SP were similar, both being slightly greater than DS. With the lower soluble N content of SP than of PP and DS, slower disappearance during the first 4 hr of incubation was expected. Rate of N disappearance from 4 to 12 hr for DS and PP tended to be greater than for SP. However, PP possessed a considerably slower N disappearance rate from 12 to 20 hr.

Steer Experiment

Ruminal, postruminal and total tract organic matter (OM) digestibility coefficients (Table 3) did not differ ($P>.05$) between treatments. Ruminal starch digestion (Table 3) tended ($P>.05$) to be greater for CSM diets than for the NC diet. Greater starch intake with the NC treatment may have been responsible for this trend. Postruminal and total tract starch digestion tended to be greater for the SP than for the DS or PP diets. The slightly greater amounts of N leaving the rumen undegraded with the SP diet may have altered the quantities, particle sizes and flow rate of starch to the duodenum or increased starch degradation or absorption in the small or large intestines.

Table 3. Site and extent of digestion of various dietary constituents.

	Diet			
Item	DS	PP	SP	NC
Organic matter, %				
Ruminal	69.3	69.4	66.4	66.5
Postruminal	15.5	16.6	20.2	21.5
Total tract	84.8	86.0	86.3	88.0
Starch, %				
Ruminal	80.1	79.5	78.0	72.4
Postruminal	8.9	12.4	15.4	17.3
Total tract	89.0	91.9	93.4	89.7
Fiber, acid detergent, %				
Ruminal	53.2	54.8	49.3	59.8
Postruminal	7.2	6.4	8.1	6.3
Total tract	60.4	61.2	57.4	66.1
Microbial efficiency, g MN/kg organic matter fermented	9.3	8.8	9.3	9.5
Ruminal bypass of supplemental protein, % of intake	27.2	31.7	33.0	-
N, % digested in total tract	77.1[a]	75.6[ab]	76.1[ab]	71.8[b]

[ab] Means in a row with different superscripts differ ($P<.05$).

Ruminal, postruminal and total tract ADF digestibilities (Table 3) did not differ, but ruminal and total tract ADF digestion tended to be lower for the SP diet. This may have been due to the higher PIN or EE content of the SP diet. Microbial efficiency estimates were similar for all treatments. Ruminal protein bypass of CSM N did not differ (27.2, 31.7 and 33.0 percent for DS, PP and SP, respectively). Higher bypass values of 24 and 61 percent for DS and SP CSM N have been observed (Zinn et al., 1981). Our estimates of ruminal protein bypass for DS and PP CSM agree with values recently determined with dairy cows (34.7; and 35.3 percent; Goetsch et al., 1984). However, bypass of SP CSM in our trial was much lower than in the dairy cow study (33.0 vs 57.0). Ruminal passage rates were not measured in either trial, but it is likely that faster rates of digesta exit from the rumen existed in the dairy cow study because of higher feed intakes. Hence, a greater competition between rate of digestion and passage rate may have occurred in the dairy cow study. Perhaps the lag time for digestion and(or) rate of digestion of only SP CSM was conducive for allowance of substantial quantities of ruminal washout of potentially digestible protein.

Literature Cited

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