Protein Bypass Estimates for Finishing Steers

R. A. Zinn and F. N. Owens

Story in Brief

Protein bypass has been measured for five different protein sources using steers equipped with intestinal cannulas. Bypass decreased with higher amounts of roughage in the diet. To predict bypass, a combination test of solubility and disappearance from polyester bags was devised. Bypass of specific feed proteins varies with 1) level of roughage, 2) level of feed intake and 3) time of digestion in the rumen. Consequently, a bypass value determined with one intake level and one roughage level is not applicable to other feeding conditions. Intestinal digestibility of protein may be estimated by digestion of the protein source with pepsin.

Introduction

Value of supplemental protein for high producing dairy cattle and rapidly growing young steers is dependent on the amount that escapes degradation in the rumen and passes to the small intestine for digestion. High bypass proteins are widely advertised, and chemical treatments to increase bypass have been developed. Bypass values for different sources have been sought in many trials, and values for protein sources based on bypass have been calculated. Bypass values also differ among experiments. Bypass trials with animals are expensive and complex to conduct, so methods to predict bypass have been sought. To develop chemical methods to predict bypass, reliable bypass values from animals are needed.

Materials and Methods

Passage of several protein sources to the small intestine was measured using steers equipped with cannulas at the start of the small intestine. Bacterial protein was subtracted from total flow based on nucleic acid content of bacteria and of intestinal samples. Flow of protein to the intestine with or without the added protein was measured and bypass calculated. The difference was expressed as a percentage of the protein source fed. Bypass of soybean meal (SBM), cottonseed meal (CSM), dehydrated alfalfa meal (Dehy) of two types, meat meal (MM) and hardened casein (HCAS) were estimated with an 80 percent concentrate ration (Table 1). Bypass of soybean meal and cottonseed meal were also measured with a 40 percent concentrate ration which would be more similar to a starting feedlot or a dairy ration (Table 1). Steers also had cannulas at the end of the small intestine so digestibility in the small intestine could be measured. Additional characteristics of these protein sources which were measured included solubility in a salt solution, indigestibility by a pepsin-HCl mixture and disappearance from dacron bags suspended in the rumen of steers fed the diets being fed.

Table 1. Composition of basal diets

Ingredient	Concentrate Trials 1 and 2	Roughage Trial 3
	%	
Chopped prairie hay	20.0	60.0
Dry rolled corn	74.4	16.0
Soybean meal	—	9.9
Starch	—	5.0
Solka floc	—	5.0
Molasses	2.0	1.0
Urea	1.2	1.0
Trace mineral salt	.3	.3
$CaCO_3$	.6	—
$CaHPO_4$	.3	1.0
Na_2SO_4	.3	.2
KCl	.7	.4
Cr_2O_3	.2	.2

Results and Discussion

Bypass values for the protein sources tested are presented in Table 2. Bypass of SBM and CSM were considerably lower when fed with a roughage than with a concentrate ration. This confirms earlier measurements with dehy as a source of protein which showed that ration composition influences bypass (Zinn and Owens, 1980). Bypass was not related to solubility of the protein source. Casein was of a "hardened" variety and had a lower solubility (Table 2) than most types of casein and also had a higher bypass than in a previous study (Zinn et al., 1981). So solubility within a single protein source may sometimes be a predictor of bypass. Degradation rates in the rumen were measured for periods up to 24 hr. Since disappearance from dacron bags during the first 4 hr would include the fraction which is soluble in a dilute salt solution plus fine material which will sift through pores in the dacron bag, the first 4 hr of ruminal digestion were ignored. Disappearance rates for subsequent 8 and 12-hr periods differed by type of ration being fed, with the higher roughage ration having much higher degradation rates.

Table 2. Bypass and chemical characteristics of proteins

	Bypass, %		Solubility	Dacron bag disappearance			
	Ration		in .15 N	Concentrate diet		Roughage diet	
Item	Conc.	Rough.	NaCl	4-12 hr	12-20 hr	4-12 hr	12-20 hr
SBM	43	24	27,27	3.6	5.2	5.7	6.9
CSM	50	43	33,12	2.2	3.4	4.6	1.6
Dehy 1	57		42	0	1.0	5.3	1.4
Dehy 2	62		23	0	1.7	3.2	4.0
MM	76		24	0	.9	1.5	.2
Casein	36		6	8.6	8.3		

Assuming bypass includes the fraction which is insoluble and not degraded from nylon bags, bypass values were predicted based on the amount of protein which is insoluble plus the rates of degradation at the various times. Predicted bypass values are compared in Figure 1 with measured bypass from these studies and one previous study. The relationship suggests that bypass may be predictable based on one chemical measurement—protein solubility—plus an index of ruminal activity of animals fed the diet of interest—disappearance from dacron bags. Systems employing chemical or enzyme measurements alone or dacron bag measurements with only one diet result in a single estimate for bypass and cannot account for differences in the ruminal environment.

Digestion of nitrogen, not including ammonia, in the small intestine averaged 65 percent, matching other literature estimates (62 to 67 percent). To calculate digestibility of bypassed protein, the relationship of intestinal digestibility of nitrogen to amounts of bacterial and feed protein entering the small intestine was determined. That relationship: intestinal digestibility of nitrogen (IDN)= -8.6 + .73 × bypass N + .73× microbial N indicates that true digestibility of microbial protein and bypass N are about equal at 73 percent and that the amount of protein escaping digestion is approximately equal to the amount which resists

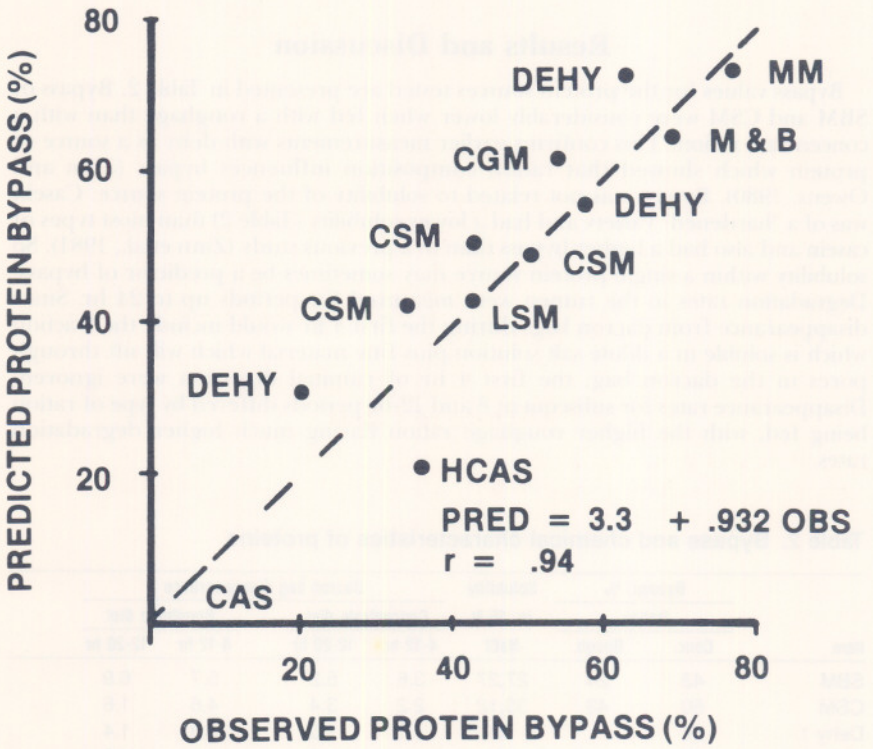

Figure 1. Observed vs predicted bypass from solubility and dacron bag values

digestion by pepsin. Pepsin digestibility can be used to calculate "intestinally digestible protein" or "metabolizable protein" values. Table 3 presents predicted bypass minus the indigestible fraction estimated by determining the amount of protein not solubilized by acid plus pepsin compared with measured "metabolizable protein." Except for dehydrated alfalfa meal, which had a much lower observed than predicted value, the relationship between expected and observed intestinally digested protein was reasonably good. Results indicate that bypass of intestinally digested protein can be predicted reasonably well based on a combination of solubility, degradation in dacron bags in the rumen and pepsin indigestibility. Solubility and pepsin indigestibility would be the primary factors with high intakes of high concentrate diets, but with higher roughage levels, all three factors appear important.

Table 3. Observed versus predicted metabolizable N value of test proteins

	Observed metabolizable N	Predicted[a] metabolizable N
	----------%----------	
Trial 1		
CSM	28	34
Dehy	32	33
SBM	32	34
Trial 2		
Casein	28	19
Dehy	21	47
MM	49	53
Trial 3		
CSM	31	35
SBM	16	15

[a]Standard reference bypass minus pepsin insoluble N.

Literature Cited

Zinn, R. A. and F. N. Owens. 1980. Feedstuffs. 52(6):28.
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