IN SITU NITROGEN AND DRY MATTER DISAPPEARANCE AND PEPSIN DIGESTIBILITY IN VITRO OF FEATHER MEAL

T.M. Murphy[1], K.S. Lusby[2], F.T. McCollum[3] and G.W. Horn[2]

Story in Brief

Two heifers, fitted with ruminal cannulae, were used to measure N and dry matter disappearance of three feather meal samples, soybean meal and four supplements. Supplements contained 23 or 40% protein. Feather meal (7.5 or 15%) replaced soybean meal in two 40% protein supplements. Samples were incubated in dacron bags in the rumen for 4, 12, 16, and 24 hours. Ruminal disappearance of N and dry matter was greater for soybean meal than for feather meal samples. Pepsin N digestibility was 89.9%, 74.3%, 62.9% and 67.3% for soybean meal and the three feather meal samples, respectively. The N and dry matter content of feather meal was found to be slowly degraded in the rumen compared to soybean meal but the extent of ruminal N disappearance between sources of FM was variable. Protein supplements containing feather meal had lower pepsin N digestibility than did soybean meal-based supplements.

(Key Words: Feather Meal, Digestion, In Vitro, In Situ, Beef Cattle.)

Introduction

Feather meal, a byproduct of the poultry processing industry, is high in crude protein (80% to 90% on DM basis). The proteins in feathers are keratins and in the raw form are poorly utilized by livestock. Treating feathers with steam and heat (hydrolyzing), or with chemicals is necessary to break disulfide bonds, characteristic of keratin proteins, and make the proteins available for animals.

Variation in the quality of FM found between sources is large. This is due to processing technique and the amounts of blood and offal added to the meal. Up to 10% of the DM of FM can consist of blood which, if added before processing, will reduce the quality of the end product. Excessive heating of blood can reduce protein digestibility and the availability of lysine

[1]Graduate Assistant [2]Professor [3]Associate Professor

and methionine. Heads and feet (offal) also can be added to the feathers under modern killing procedures. Addition of offal will increase the fat and ash content of the meal and reduce the protein percentage.

The objective of this study was to compare ruminal N and DM disappearance in situ and pepsin digestibility of N in vitro of FM to SBM. Protein supplements containing 7.5% and 15% FM were also compared to SBM-based supplements.

Experimental Procedures

In Situ.

Two ruminally cannulated heifers received 1.0 lb/day of a SBM supplement (40% CP) and were allowed ad libitum access to prairie grass hay (6% CP) for a 10-day adaptation period. This feeding program was continued throughout the sampling period of the study.

Samples used included three FM samples, two being purchased (FM-B and FM-C) and one being donated (FM-A) from different commercial sources, four pelleted protein supplements (NC, PC, 7.5% FM and 15% FM) and SBM. The FM source used in the protein supplements was FM-B. The pelleted protein supplements were ground to pass through a 2 mm screen. Composition of the supplements is shown in Table 1.

Samples were weighed, oven dried at 60°C for 24 hours, then reweighed to determine DM content. Five g of the dried samples were placed into Dacron bags, measuring 5 X 10 cm, with an average pore size of 52 micrometers. Bags were tied with wire twist ties and secured to a weighted drop line.

Prior to placement, bags were soaked in warm water (40°C) for 20 min. Lines were placed in the rumen for one of four different incubation times (4, 12, 16 and 24 hours) with three lines serving as replications of each time, for a total of 12 lines in each animal. Bags were placed in the rumen at different times but removed simultaneously to reduce variation among bags caused by different rinsing conditions and to simplify removal of bags from the rumen.

Upon removal, bags were rinsed with tap water until the rinse water was clear. Unincubated samples (0 hours) were also placed into bags and washed. Bags were drip dried, placed in a forced-air oven and dried at 50°C for 24 hours, removed, and dried for 24 hours at 60°C. Each bag then was weighed to determine DM content. Samples (.2 g) from each bag were removed and N analysis performed using the micro-Kjeldahl technique. The N residue (g) was divided by the N content (g) in the bag prior to incubation to determine the percent of N remaining after exposure.

Table 1. Composition of supplements for in situ trial (DM basis).

			Feather meal	
	NC	PC	7.5%	15%
Ingredients, %				
Soybean meal	43.50	90.50	73.70	58.25
Feather meal			8.00	15.50
Milo	48.45	4.00	12.00	19.00
Molasses	3.50	3.50	3.50	3.50
Dicalcium phosphate	2.70	1.90	2.10	2.50
Potassium chloride		1.75	0.60	1.15
Vitamin A[a]	0.1	0.1	0.1	0.1
CP, %	26.32	44.87	44.74	44.71

[a] 6060 IU/kg.

Pepsin Digestibility.

Pepsin-HCl procedures were performed to determine the amount of potentially digestible N in FM and the protein supplements. One g of each sample and supplement was placed in a flask along with 1 g of pepsin and 100 ml of 0.1N HCl. Flasks were swirled and incubated in a water bath (39°C) for 20 hours. After incubation, contents were rinsed with double distilled water through No. 4 Whatman filter paper to remove the soluble N fraction. Micro-Kjeldahl procedures were then performed on the residues to determine the amount of indigestible N in the samples and supplements. The amount of N remaining was subtracted from the initial N to obtain an estimate of pepsin digestible nitrogen. Three replicates of each sample were used.

Statistical Analysis

In Situ.

Data were analyzed by least squares ANOVA using the General Linear Models (GLM) procedure of SAS (1985). Data for the FM samples and SBM were analyzed separately from the protein supplements. A mean value was obtained from the three bags of each sample or supplement at each time

within each animal. The original statistical model used for the SBM and FM samples included the effects of treatment and animal with the interaction of treatment by animal used as the error term. A separate analysis was performed within each different time period. Because animal effects were not significant, only treatment effects were used in the final analysis. For the protein supplements, the same procedures were followed except that a significant animal effect was seen at 12, 16 and 24 hours; therefore, animal effects were included in the final analysis.

Pepsin HCl.

Data were analyzed by least squares ANOVA using the General Linear Models (GLM) procedure of SAS (1985). The statistical model used included only treatment effects. Again, samples and supplements were separated for analysis. Orthogonal contrasts were used to determine differences between the SBM and the FM samples and among the protein supplements.

Results and Discussion

Pepsin digestibility.

The N in FM was less digestible ($P<.0001$) in pepsin-HCl than was N in SBM (Table 2). Pepsin digestibility values were 89.9, 74.3, 62.9 and 67.3% for SBM, FM-A, FM-B and FM-C, respectively. The pepsin N digestibility of the PC supplement was greater ($P<.05$) than for either of the FM supplements (Table 3). The digestibility values were 90.2, 88.0, 83.1 and 76.5% for PC, NC, 7.5% FM and 15% FM, respectively. The lower N digestibility for the supplements containing FM is in agreement with the observed lower N digestibility.for the FM (FM-B) used in formulation.

In Situ.

The percentages of N and DM degraded at various times for the FM samples are presented in Table 2. The amount of N that was washed out at 0 hours was greater for SBM than FM-A or FM-B. Washout of N did not differ among FM samples. Ruminal N disappearance for SBM was greater ($P<.05$) than that of FM at all times. Nitrogen disappearance was greater ($P<.001$) for FM-A than for FM-B or FM-C across all times, but FM-B and FM-C were similar ($P>.35$) except at 4 hours. The percentage of N

Table 2. Percentage of ruminal N and DM disappearance in situ and pepsin digestibility of N in vitro of feather meal and soybean meal (least squares means).

Time, hours	Sample				
	SBM	FM-A	FM-B	FM-C	SE[a]
	Percentage N disappearance				
4	21.1[c]	17.0[d]	5.6[e]	6.4[f]	.14
12	24.0[c]	20.0[d]	9.0[e]	9.1[e]	.55
16	28.0[c]	19.5[d]	6.9[e]	8.0[e]	1.23
24	35.1[c]	20.7[d]	5.8[e]	6.8[e]	1.47
Washout[b]	5.0[c]	0.01[d]	-0.8[d]	1.5[cd]	1.28
	Percentage DM disappearance				
4	36.9[c]	17.8[d]	7.6[e]	6.2[e]	.33
12	44.6[c]	19.3[d]	9.4[e]	6.6[f]	.55
16	48.0[c]	18.9[d]	7.5[e]	6.7[e]	.61
24	55.6[c]	22.8[d]	9.6[e]	8.0[e]	1.52
Washout[b]	9.8[c]	3.3[d]	1.5[e]	1.2[e]	.24
Pepsin Digestibility	89.9[c]	74.3[d]	62.9[e]	67.3[f]	1.15

[a] Standard Error.
[b] Amount rinsed from unincubated bags.
[c,d,e,f] Means on the same row with same superscript do not differ ($P < .05$).

disappearing after 24 hours was 35.1, 20.7, 5.8 and 6.8% for SBM, FM-A, FM-B and FM-C, respectively.

The DM disappearance of the SBM and FM samples reflected the N disappearances observed (Table 2). Soybean meal had the greatest ($P < .001$) DM disappearance at all times. Dry matter disappearance differed for the FM samples. At 24 hours, DM disappearance values were 55.6, 22.8, 9.6 and 8.0% for SBM, FM-A, FM-B, and FM-C, respectively.

For the protein supplements, the percentage of N degraded at 4 hours tended to be less ($P < .09$) for NC than any of the 40% CP supplements, but

no differences (P>.76) were noted among the 40% CP supplements (Table 3). Low disappearance may reflect the large amount of milo in the NC supplement. At 12 hours, more N (P<.05) had disappeared from NC than either of the FM supplements. By 24 hours, the N disappearance among protein supplements was similar (47.1, 47.9, 44.2 and 39.6% for PC, NC, 7.5% FM and 15% FM, respectively). The DM disappearance for the protein supplements followed the same trends as N disappearance at 4 hours.

Table 3. Percentage of ruminal N and DM disappearance in situ and pepsin digestibility of N in vitro of protein supplements (least squares means).

	Supplement				
			FM	FM	
Time, hours	PC	NC	7.5%	15%	SE[a]
			Percentage N disappearance		
4	28.0	21.9	28.3	27.5	1.64
12	35.9[cd]	41.9[d]	32.4[c]	33.3[c]	1.71
16	38.9	41.4	35.1	33.7	1.76
24	47.1	47.9	44.2	39.6	2.18
Washout[b]	4.8[c]	11.2[d]	3.6[c]	3.6[c]	1.74
			Percentage DM disappearance		
4	44.0	38.4	43.4	41.7	1.55
12	51.0	50.0	50.3	50.0	.91
16	55.2	52.7	53.9	51.0	1.09
24	63.2	59.8	60.7	58.5	3.38
Washout[b]	13.5	14.1	13.5	12.4	.56
Pepsin Digestibility	90.2[c]	88.0[d]	83.1[e]	76.5[f]	.63

[a] Standard Error.
[b] Amount rinsed from unincubated bags.
c,d,e,f Means on the same row with same superscript do not differ (P<.05).

No effect of supplement was observed and the 24-hour DM disappearances were 63.2, 59.8, 60.7 and 58.5% for PC, NC, 7.5% FM and 15% FM, respectively.

In conclusion, N digestibility of the FM samples used in this study was variable. The FM sample donated by a commercial byproduct distributor (FM-A) was the highest quality meal, based on its greater N digestibility and in situ N disappearance, while those that were purchased from commercial mills (FM-B and FM-C) were of equally poor quality. A difference in the physical appearance of the meals was observed. The two purchased meals (FM-B and FM-C) had a darker and more oily appearance with larger particles present. The dark color could reflect over-processing or an increased blood content, while the presence of large particles could indicate greater offal content. In both instances a lower quality product would be produced because of decreased availability of N and amino acids and an increased fat and ash content. By the AAFCO definition, the pepsin digestibility of the CP of FM must be no less than 75%. The donated meal FM (FM-A) came close to this requirement (74.3%), while the purchased meals were considerably lower (62.9 and 67.3% for FM-B and FM-C, respectively). Feather meal may have a value equal to plant proteins under certain processing conditions, but the large variation found in the N availability of feather meals, from different commercial sources, render FM of questionable value as a source of crude protein in winter supplements for beef cattle unless strict quality control is exercised.