

DETERMINATION OF PROTEIN DEGRADATION IN THE RUMEN AND INTESTINE OF HEIFERS USING A MOBILE DACRON BAG TECHNIQUE

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Story in Brief

A mobile dacron bag technique was used to estimate protein digestibility of feedstuffs in heifers fitted with rumen and duodenal cannulae. Heifers were fed a wheat- or corn-based ration with sorghum silage as the only forage. Following grinding through a 2-mm screen, approximately 2.25g samples of dry wheat, wheat mixture (60% wheat), corn, or corn mixture (55% corn) were placed in dacron bags. Bags were suspended in the rumen for 15 hours and then incubated for 3 hours in a pepsin-HCl solution at 37°C. Following incubation, bags were inserted into the proximal duodenum at a rate of 2 bags per hour and recovered in the feces. Bags were washed thoroughly, dried, and contents analyzed for protein. Protein disappearance after 15 hours in the rumen for wheat, wheat mixture, corn and corn mixture was 65.5, 41.1, 33.3 and 28.8%, respectively. After rumen incubation plus pepsin digestion plus intestinal passage disappearance was 96.9, 98.3, 91.5 and 86.8%, respectively. The mobile dacron bag technique appears to be a promising approach for a rapid determination of cumulative protein digestibility in feedstuffs.

(Key Words: Mobile Dacron Bag, Protein Disappearance, Wheat.)

Introduction

The practice of using wheat in livestock rations depends upon how useful it is for various classes of animals and whether supplies of wheat are available at competitive prices. However, to what extent wheat can be substituted for other grains and yet maintain productivity remains to be defined. When Faldet et al. (1986) fed concentrate mixtures containing 0, 40, and 60% wheat to lactating dairy cows with sorghum silage as the only forage, milk yield decreased significantly in a linear trend as the level of wheat in the concentrate increased. Milk yield was 28.8, 28.0, and 27.3 kg/day for the cows fed rations wherein wheat was 0, 40, and 60% of the concentrate mixture. The rumen undegradable protein of the concentrate mixture was decreased considerably from 8.2% in the mixture containing corn to 5.8% for the mixture with 60% wheat. In particular, the amount of lysine in the concentrate mixture that would be expected to escape ruminal degradation was reduced from .41% for the corn mixture to .26% for the mixture containing 60% wheat.

When Khadanovich et al. (1986) fed rations containing 0 and 29% wheat to lactating cows, average daily milk yield was 22.06 and 19.56 kg/day and degradability of the protein of the feed mixtures in rumen liquid was 77.0 and 87.4%. Lebzién et al. (1984) fed rations where wheat and maize protein provided 39.5 and 28.9% of total crude protein.

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The proportion of rumen undegraded feed protein was 25% with maize and 9% with wheat.

The objective of this experiment was to determine the extent of protein degradation in the rumen and in the intestines for wheat, wheat mixture, corn and corn mixture.

Materials and Methods

Two Hereford heifers fitted with ruminal and duodenal cannulae were fed a ration consisting of a wheat- or corn-based concentrate mixture (Table 1) and sorghum silage throughout the experiment. These made up 55 and 45% of the ration on a dry basis. Animals were adjusted to the diets for a period of 7 days and were fed twice daily.

Bags, measuring 3.0 by 5.0 cm, were made of dacron with a mesh size of 60 to 70 microns. Approximately 2.25g of dry feed, i.e., wheat, corn, wheat mixture or corn mixture, ground using a 2mm screen, were placed in each bag which was sewn and glued. Bags containing the wheat or wheat mixture were placed in the heifer fed the wheat-based ration and bags containing corn or corn mixture in the heifer fed the corn-based ration; these were inserted into nylon stockings and incubated in the rumen for 15 hours. Afterwards, they were incubated in pepsin-HCl solution (1g pepsin/l; .1N HCl) adjusted to pH 2 at 37^o.5 C. for 3 hours with constant stirring. After rumen and pepsin digestion, bags were introduced into the small intestine via the duodenal cannula, recovered from the feces, washed and dried in a forced air oven at 60^o C. for 48 hours. The contents of each bag was subjected to Kjeldahl nitrogen analysis.

Table 1. Concentrate mixtures fed with sorghum silage¹

Composition	Corn	Wheat
Ingredients, % as fed		
Wheat	-	60
Corn	55	-
Oats	5	5.5
Soybean meal	25	20
Cottonseed meal	5	4.5
Fixed portion ²	10	10
Calculated analysis (as fed)		
Net energy, Mcal/100 lb	72.1	73.0
Crude fiber, %	6.3	6.2
Total protein, %	19.0	19.0
Rumen undeg. protein, %	7.56	5.41
Rumen undeg. lysine, %	.36	.24

¹Concentrate: Forage, 55:45 (dry basis), total protein 14.5% and crude fiber 16.8%.

²Fixed portion of concentrate mix: Cottonseed hulls 5, limestone 1.5, dicalcium phosphate 1.25, sodium bicarbonate 1.0, salt .75 and magnesium oxide .5%.

Disappearance of protein from the dacron bags was measured after 5 different procedures: rumen incubation, rumen incubation plus pepsin digestion, rumen incubation plus pepsin digestion plus passage through the intestines, bags washed plus pepsin digestion, bags washed plus pepsin digestion plus passage through the intestines.

Results and Discussion

The crude protein percent of the feedstuffs was 15, 9, 19, and 19% for the wheat, corn, wheat mixture and corn mixture, respectively.

The percentage of protein disappearance from wheat in the rumen was 65%, whereas for corn it was only 33%. On the other hand, the disappearance of protein in wheat and corn during passage through the entire tract was similar, i.e., 97 and 91%, respectively. Nalsen et al. (1987) found that the amount of protein that was calculated to escape ruminal degradation and enter the small intestine was a critical factor for maximum milk production.

There was no protein disappearance of the wheat mixture after pepsin digestion, which is probably due to error in the analysis or insufficient samples tested. Since zero was considered to be an unreasonable value for the amount of disappearance, it is listed as a missing value (Table 2). Disappearance of protein after pepsin digestion was 26% for the corn mixture. The disappearance of protein of the wheat and wheat mixture was similar with pepsin plus intestinal digestion as was the disappearance in the complete tract, i.e., 96.9 and 98.3%, respectively. It was very interesting that the disappearance of protein from corn after rumen incubation plus pepsin digestion was only 33%, whereas complete digestion was 91%. This suggests that the corn escaped digestion in the rumen and treatment with the pepsin-HCl solution, but it was digested in the intestines. These results are in agreement with those of Barrio et al. (1986) with high-moisture corn in that disappearance of protein in the rumen was 40% at 12 hours. The disappearance of protein from the wheat mixture in the rumen and rumen plus pepsin digestion was similar, 41 and 43%, respectively. The digestion of protein of the wheat mixture in the complete tract was only 4% units higher than the pepsin plus intestinal digestion. Disappearance of protein of the corn mixture was similar to that of the corn, except that the disappearance increased 11% units between the rumen and rumen plus pepsin digestion. The mobile dacron bag technique appears to be a promising approach for a rapid determination of cumulative protein digestibility in feedstuffs.

Table 2. Protein disappearance of four different feedstuffs from mobile dacron bags.

Procedure	Wheat	Corn	Wheat mix	Corn mix
A: Pepsin digestion	41.8	27.5	--	26.4
B: Rumen incubation	65.5	33.3	41.1	28.8
A + Intestinal digestion	93.7	67.1	94.5	77.0
A + B	82.5	33.1	42.9	39.5
A + B + Intestinal digestion	96.9	91.5	98.3	86.8

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