THE RUMEN DEGRADABILITY OF PROTEIN FOR VARIOUS FEEDSTUFFS

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Introduction

For the evaluation of dietary protein in feedstuffs for the ruminant, the rumen degradability of protein (dg) has been postulated[1] and has received much attentions. The dg values for various feedstuffs commonly used, however, were scarcely reported in this country. The present study was purposed to determine the dg values for various feedstuffs commonly used in dairy and beef industry in this country by means of *in sacco* technique using yearling steers cannulated in the rumen.

Materials and Methods

The Holstein castrated male calves were fitted with the rumen cannulae at 8 weeks of age after weaned at 6 weeks of age. Measurements of the dg values for various feedstuffs started at one year after the cannulation operation. Steers were fed at maintenance level of a mixed ration consisting of formula feed and orchardgrass hay with a ratio of 6 : 4. Feedstuffs used were 10 protein supplement feeds, 12 grains and by-products and 3 roughages (Table 1)***.

The rate of degradation of protein in the rumen was determined by *in sacco* technique described by ØRSKOV and MCDONALD[3]. The nylon bag used was made with 300 mesh (pore size, 48 μ) nylon fabrics. The bag was 5 × 10 cm in size and contained 2 g of samples ground through 3 mm screen and 2 steel balls (about 11 g) as a weight. Bags with duplicates were incubated in the rumen for 3, 6, 9, 15, 24 and 48 hours. After incubation,

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bags were vigorously washed to eliminate the ruminal digest on them and then, in running water until wash-out water became clear. After being washed, residuals were dried in a forced air oven at 55°C. Air dried residuals were determined for dry matter by drying at 135°C and for nitrogen by

TABLE 1. The effective rumen degradability of the protein in various feedstuffs together with those reported

Feed	Effective rumen degradability of protein		
	Present study	Calculated*	A R C
	%		
Corn	51	—	51—70
Steam rolled corn	33	—	—
Grain sorghum	39	—	31—50
Steam rolled grain sorghum	28	—	—
Barley	70	88	71—90
Steam rolled barley	69	—	—
Oats	84	—	—
Steam rolled oats	80	—	—
Wheat flour	88	—	71—90
Wheat bran	85	85	—
Dried brewers' grains	56	—	—
Soybean meal	76	82	71—90
Steam rolled sobyean	90	—	—
Cottonseed meal	55	—	51—70
Cotton seed	83	—	—
Linseed meal	78	75	51—70
Rapeseed meal	71	70	71—90
Sunflower meal	84	—	71—90
Corn gluten meal	18	21	—
Fish meal (60% C. protein)	52	—	31—50
Blood meal	23	—	—
Meat and bone meal	51	—	31—50
Pelleted alfalfa	70	60	51—70
Orchardgrass hay, 1st cut	71	—	71—90
Dried mandarin orange pulp	64	—	—

* Calculated from the values of constants reported by SHIBUI *et al.*[4] and k (0.034) determined in the present study

Kjeldahl method.

The rate of disappearance of protein (p) in the rumen was expressed as a function of incubation time (t), fitting the following equation, $p=a+b(1-e^{-ct})$, presented by ØRSKOV and McDONALD[3]. Values of constants, a, b and c were determined using iterative least square method.

To determine the rate of ruminal passage of digest (k), chromium inpregnated cell wall constituents (Cr-CWC) were prepared with the method described by UDEN *et al.*[5]. The preparation of Cr-CWC was administered through the rumen cannulae at the time of morning feeding with a rate of 1% of feed intake. After the administration of Cr-CWC, feces were collected at 4-hour intervals for 5 days and were analyzed for chromium concentration by the method described by YOSHIDA *et al.*[6]. The value of k was determined using the model of the first order kinetics presented by Grovum and Williams[2].

The effective dg was calculated with the following equation, effective $dg=a+b\times c/(c+k)$, reported by ØRSKOV and McDONALD[3] using the values obtained for constants of a, b, c and k.

Results and Discussion

There was no significant difference in the effective dg values calculated using the rates of disappearance for nitrogen obtained from the 24-hour and the 48-hour incubations in the rumen. Thus, the dg values were presented by those calculated using the results obtained from the 24-hour incubation. The dg values ranged from 18 to 90% for the proteins in feedstuffs determined in the present study. Table 1 shows the dg values for an individual feedstuffs together with those reported by ARC[1] and calculated using constants reported by SHIBUI *et al.*[4] and the average rate of passage ($k=0.034$) obtained in the present study. The values for 13 feedstuffs reported by ARC[1] were collected from the experimental results reported with wide range of techniques for the determination of the dg values using animals including mature cows. The values obtained in the present study well agreed with those of 13 feedstuffs reported by ARC[1]. Those for 7 feedstuffs calculated using the constants reported by SHIBUI *et al.*[4] also showed a fairly well agreement with the values determined in the present study. The dg values for corn gluten meal and blood meal had been expected to be low, but there had been no reported value so far. The present study was the first to actually determine to demonstrate their values being 18% and 23% for corn gluten meal and blood meal, respectively.

The dg values of the protein in grains varied in wide range. The

protein in grain sorghum showed relatively low value of degradability, while those of wheat flour and oats were high in dg values. Those of corn and barley were intermediately ranked. The protein in grains showed a different response in the dg values when they were processed by steam rolling. The proteins in corn and grain sorghum decreased the dg value, while those of barley and oats showed no change in the dg value.

The protein of roughage appeared to be higher in the dg values, since first cut orchardgrass hay and pelleted alfalfa showed the dg value of about 70%. Dried mandarin orange pulp was intermediately ranked. Thus, the protein in the pulp of fruits which is considered to be roughage for ruminants might have a different dg value from those of common forage crops.

The dg value for dried brewers' grains was lower than that for barley. Although brewers' grains does not totally consist of barley itself, the result obtained shows that heat in the fermentation process may be partially responsible for reducing the dg value of protein in a grain.

The feedstuffs determined for the dg value in the present study were far from covering common feedstuffs for cattle used in this country. Thus, further determination of the dg values for various feedstuffs needs to be done for other feeds than those determined in the present study. The interrelation among feedstuffs also needs to be considered when they are mixed for a ration.

Summary

The rumen degradability of protein for 25 commonly used feedstuffs were determined by *in sacco* technique using yearling steers cannulated in the rumen. The values of protein degradability for various feedstuffs were categolized in the following manner. Feeds having the dg value less than 30% were corn gluten meal, blood meal and steam rolled grain sorghum. Those having the value ranging from 31 to 50% were grain sorghum and steam rolled corn. Those having the value ranging from 51 to 70% were cottonseed meal, fish meal, meat and bone meal, corn, barley, steam rolled barley, brewers' grains, pelleted alfalfa and mandarin orange pulp. Those having the value over 70% were soybean meal, linseed meal, rapeseed meal, sunflower meal, steam rolled soybean, oats, steam rolled oats, wheat flour, wheat bran, cotton seed and 1st cut orchardgrass hay.

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