Acta Veterinaria(Beograd), Vol. 45. No. 2–3, 149–154, 1995.

UDK 619:612.015.33

PROTEIN DEGRADABILITY IN RUMINANT FEEDS OF ANIMAL ORIGIN

G. GRUBIĆ*, LJILJANA SRETENOVIĆ**, LJ. STOIĆEVIĆ**, M. ADAMOVIĆ** and R. JOVANOVIĆ**

**Institute of Animal Production, Faculty of Agriculture and **Institute of Animal Production, MP "INI-AGROEKONOMIK d.d.," Belgrade, Yugoslavia*

(Received, 15. March 1995.)

Protein degradability was examined by a standard in situ method with three ruminally cannulated sheep. The feedstuffs investigated were: fish meal, meat meal and meat and bone meal. It was found that in situ effective degradability of their crude protein was: 26.96, 43.25 and 44.92% respectively (with an expected ruminal outflow rate of k=0.05). The values obtained are not very dissimilar to those obtained in other investigations. It is concluded that there is great heterogeneity of protein degradability in feeds from animal sources. It is stressed that the main reasons for these differences arise from the diverse technological processes of preparation (especially heat processing) and the quality of the raw material.

Key words: protein degradability, fish meal, meat meal, meat and bone meal

INTRODUCTION

A few decades ago it was found that some feeds of animal origin have certain beneficial effects in ruminant feeding. Since investigations of protein degradability in ruminant forestomachs started, it has gradually become more obvious why those effects exist. It was found in several works that feeds of animal origin have a slow degradation rate in the rumen. With the introduction of new systems for estimating protein, such feeds became better evaluated as protein sources. It became possible, with more certainty, to decide when to use them in cattle, sheep or goat feeding.

The aim of this investigation was to determine protein degradability in the rumen, using an in situ method, for some feeds of animal origin, used in ruminant feeding in Yugoslavia.

MATERIALS AND METHODS

The in situ method involved ruminally cannulated sheep as explained by Grubić et al. (1994). Three male sheep were used (Il le de France, body weight 75 kg) and each feed was incubated in each animal. Every feed sample was

incubated in triplicate for the following intervals: 0, 6, 12, 24, 48 and 96 hours. Dry matter (DM) was determined by drying, first at 60^0 (and later at 100 ± 5^0C.

The crude protein (CP) content was determined by standard Kjeldahl procedure with a Tecator auto analyzer. The feeds were analyzed in the "BIOLAB" laboratory "INI Agroekonomik" d.d..

Mathematical and statistical processing of the data was done by a least squares procedure after fitting the Orskov and McDonald (1979) model:

$$D = a + b\,(1 - e^{-ct})$$

The value 'a' represents the soluble fraction extrapolated from the exponential portion of the curve when time (t) is zero, 'b' - the less available but degradable fraction and 'c' - the degradability rate constant (%/hour). The sum 'a+b' is the total portion of CP that can be degraded in the rumen. 'D' is the CP degraded in time 't'.

The effective or real degradability was calculated according to the equation given by Orskov and McDonald (1979): $ED = a + bc/(c+k)$

where parameters 'a', 'b' and 'c' are the same as in the previous equation, and 'k' is the outflow rate from the rumen (0.05 in this case).

Table 1. Dry matter and crude protein content in the feeds investigated (%)

Feed	Dry matter	Crude protein
Fish meal	89.64	61.82
Meat and bone meal	93.62	45.52
Meat meal III. quality grade	94.52	45.96

RESULTS AND DISCUSSION

The contents of DM and CP found in the feedstuffs investigated are shown in Table 1.

The effective degradability results obtained in this study are shown in Table 2, and values for the same feeds of similar quality from other investigations in Table 3.

Protein degradability values found for these kinds of feeds are as a rule, very variable.Thus, NRC (1988) reported an effective degradability value of 40% for the most often investigated fish meal as an average of 26 observations. On the market it is possible to find very different products under the name "fish meal", so their protein degradability may vary from 28.8% (De Boer et al. 1986), to 70% (Madsen and Hvelplund, 1990). The results of our investigation are close to those recorded by Ha and Kennely (1984) and De Boer et al. (1986). ARC (1984) observed even lower crude protein degradability (22%) in well preserved white fish meal.

Table 2. Protein degradability parameters in the feeds investigated

Feeds	Parameters a (%)	b (%)	c (%/h)	$ED_{0,05}$ (%)
Fish meal	13.55	80.43	0.010	26.96
Meat and bone meal	31.56	24.98	0.058	44.92
Meat meal III. quality grade	34.79	25.73	0.025	43.25

With meat meal the situation was similar. NRC (1988) gave a value of 24% for protein degradability of this feed. Susmel et al. (1989) and Petit (1992) reported values in the range 52 - 55% The values found in our investigation were within the expected margin.

The effective protein degradability values of meat and bone meal in other investigations varied from 37 to 79%. Madsen and Hvelplund (1985) cited average value of 66% (from 52 to 79%) for this feed. Later, the same authors (Madsen and Hvelplund, 1990) gave a value of 55%, whereas Satter and Stehr (1984) reported 35%, and ARC (1984) 45%. As an average of five investigations NRC (1988) suggested the value of 51%. Our result is almost the same as that given by ARC (1984) - 44.9%.

The general observation for the feeds investigated is that all had a comparatively low protein degradability. The protein present in feeds of plant origin is usually more degradable in the rumen. This is expected, because the microorganism population in the rumen developed through a long period of evolution where ruminants consumed only plant feeds. Therefore, those microorganisms are not used to digest protein from feeds of animal origin. This feature has become very useful for manipulating protein degradability when formulating diets for the ruminants with high producing potentials that exist today.

The great diversity in protein degradability of feeds of animal origin, observed in different investigations is probably due to differences in processing and production technology. It is particularly connected with heat processing, which forms part of the production procedure for all feeds of animal origin. The quality of the original material from which the feed was made had also a significant influence. Sniffen et al. (1979) concluded that heat processing differed significantly between various manufacturers. They suggested that the producers should pay more attention to factors that may affect the protein complex in their products, because this may have a major influence on their possible use in ruminant feeding.

Pichard and Van Soeset (1979) explained that heat processing of feeds may disrupt the protein complex and cause changes that make it unavailable to the animal. Unfortunately, there was no precise information about the changes that occur after certain processing conditions. This is the domain that has to be investigated further in the future, because there are very interesting possibilities for preparing feeds with special purposes for ruminant or nonruminant feeding.

Table 3. Protein degradability data for feeds of animal origin as found in some investigations

Feed/author	Dry matter (%)	Crude protein (%)	a (%)	b (%)	c (%)	$ED_{0.05}$ (%)
FISH MEAL						
Susmel et al. (1989)	91.9	58.1	23.2	26.2	0.107	41.1
Broderick et al. (1988)	90.0	62.2	33.5	57.3	0.014	46.0
De Boer et al. (1978)	97.8	60.1	21.7	20.1	0.108	35.4
Petit (1992)	96.5	63.9	28.2	33.3	0.190	54.4
MEAT MEAL						
Susmel et al. (1989)	91.1	61.2	19.5	48.8	0.134	55.0
Petit (1992)	97.9	59.7	26.1	33.7	0.190	52.4
MEAT AND BONE MEAL						
Broderick et al. (1988)	95.0	45.5	38.8	63.7	0.017	55.0
De Boer et al. (1987)	96.2	47,4	24.2	32.7	0.248	51.4

CONCLUSION

From the results obtained the following conclusions can be drawn:

— Effective degradability of crude protein detected by the in situ method was 26.96% for fish meal, 43.25% for meat meal and 44.92% for meat and bone meal.

— These results are within the range of those found by other authors who investigated the same types of feeds.

— The reason for the large diversity in the results obtained in various investigations may be attributed to differences in production technology, heat processing and the quality of the starting material for feeds of animal origin.

REFERENCES

1. *ARC.* 1984. The nutrient requirements of ruminants livestock. Suppl. 1. Report of the protein group of the ARC working party. *Commonwealth Agricultural Bureau. Farnham Royal. U.K.*

2. *Broderick, G. A., Wallace, R. J., Orskov, E. R. Hansen L.,* 1988. Comparison of estimates of ruminal protein degradation by in vitro and in situ methods. *J. Anim Sci. 66,* 1739.

3. *De Boer. G. Murphy, J. J., Kennely, J. J.* 1986. A modified method for determination of in situ rumen degradation of feedstuffs. *Can. J. Anim. Sci.* 67:93.

4. *De Boer, G., Murphy, J. J., Kennely, J. J.* 1987. A rapid method for estimating protein digestibility in ruminants. *Univ. of Alberta Feeders Day Report.* p, 58.

5. *Grubić, G., Jovanović, R., Adamović, M., Stoićević, Lj., Sretenović, Lj., Šestić, S.,* 1994. Postupak određivanja razgradivosti proteina metodom in situ. *Biotehnologija u stočarstvu. God. 10. No.1-2.* Str. 121-128. Beograd.

6. *Ha. J. K., Kennely, J. J.* 1984. In sity dry matter and protein degradation of various protein sources in dairy cattle. *Can. J. Anim. Sci.* 64, 443.

7. *Madsen, J., Hvelplund, T.* 1985. Protein degradation in the rumen. *Acta. Agric. Scand. Suppl. 25,* 103-124.

8. *Madsen, J., Hvelplund, T.* 1990. Feedstuffs table. The composition and protein values of feeds. A study of the quantitative nitrogen metabolism in the gastro-intestinal tract, and the resultant

new protein evaluation system for ruminants. The AAT-PBV system. *Inst.of Anim. Sci. The Royal Veterinary and Agricultural University. Copenhagen. p.* 201-215.

9. *NRC.* 1988. Nutrient requirements of dairy cattle. *National Academy Press.Washington DC.*
10. *Orskov, E. R., McDonald, I.* 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. *J. Agric. Sci., Camb. 92,* 499.
11. *Petit, H. V.* 1992. In situ degradability of feed ingredients at two proportions of concentrate. *Ann. Zootech, 41,* 145.
12. *Pichard, D. G. R., Van Soest, P. J.* 1979. Protein solubility of ruminant feeds. *Proc. Cornell Nutr. Conf. p.* 91.
13. *Satter, L. D., Stehr, D. B.* 1984. Feeding resistant protein to dairy cows. *Proc. Distillers Feed Conf.* pp 59. *Cincinnati. Ohio.*
14. *Sniffen, C. J., Hoover, W., Jenkins, L.L., Crooker, B.A., Macgregor, C.A.* 1979. Variation in protein and soluble carbohydrate composition of various feedstuffs. *Proc. Cornell Nutr. conf. p,* 119.
15. *Susmel, P., Stefanon, B., Mills, C. R., Colitti, M.* 1989. The evaluation of PDI concentrations in some ruminant feedstuffs: a comparison of in situ and in vitro protein degradability. *Ann. Zootech. 38,* 269-283.

RAZGRADIVOST PROTEINA HRANIVA ANIMALNOG POREKLA KOJA SE KORISTE U ISHRANI PREŽIVARA

G. GRUBIĆ, LJILJANA SRETENOVIĆ, LJ. STOIĆEVIĆ, M. ADAMOVIĆ i R. JOVANOVIĆ

SADRŽAJ

Razgradivost proteina je ispitivana standardnom in situ metodom na tri ovna sa fistulama na rumenu. Ispitivana su sledeća hraniva: riblje, mesno i mesno - koštano brašno. Ustanovljeno je da je efektivna razgradivost proteina ovih hraniva bila, istim redom: 26,96; 43,25 i 44,92% (uz očekivani odliv sadržaja iz buraga od k=0,05). Dobijene vrednosti se ne razlikuju mnogo od onih koje su ustanovili drugi autori, postoje, međutim, velike razlike među podacima koje oni navode. Zaključak ovog rada je da postoji velika neujednačenost u pogledu razgradivosti proteina kod hraniva animalnog porekla. Osnovni razlozi za ovako velika odstupanja nalaze se u različitim tehnološkim procesima proizvodnje (posebno termičke obrade) a takođe i u kvalitetu početne sirovine od koje se hranivo proizvodilo.