Acta Veterinaria (Beograd), Vol. 49. No. 4, 269-274, 1999.

UDK 619:636.2.085.15

STARCH DEGRADABILITY OF SOME CONCENTRATE FEEDS USED IN DAIRY COW NuTRITION

D. ALEKSIĆ[1], G. GRUBIĆ[2] and A PAVLIČEVIĆ[2]

[1]*Institute for the Application of Science in Agriculture, 29. Novembra 68b, Belgrade.*
[2]*Faculty of Agriculture, Zemun - Belgrade.*

(Recrived, 10. May 1999.)

Starch degradability in eight commonly used concentrats was determined by the in situ method using two ruminally cannulated lactaing cows. The investigated feeds and their effective starch degradability at a rumen outlow rate of 5% per hour were: wheat bran 75.8%, maize grain 19.9%, oat grain 61, 7%, soybean meal 77,2%, sunflower meal 43.5%, dried sugar beet pulp 39.6%, pea grain 75.3%, faba bean graain 58.5%. For some feeds (wheat bran, maize grain) starch degradability was lower, for some higher (oat grain, pea grain) and for only one feed (faba bean grain) was it close to the results found by other authors

Key words: Concentrates, cow feeding, in situ, starch degradability

INTRODUCTION

Starch degradability in the rumen is becoming an important element in new ruminant feed evaluation systems (Russel et al. 1992, Sniffen et al. 1992). It is generaly accepted that when formulating diets for high yielding dairy cows special attention must be paid to humen fermentation characteristics of the feeds used. The ratio of structural (cellulose, hemicellulose and lignin) to non-structural carbohydrates (starch, sugars, pectin etc.) in the det is very important for successful feed utilization in ruminants. Ruminal digestion of protein and starch depends on the intrinsic characteristics of the feed (degradability) and on the intensity and duration of bacterial activity in the rumen (Cerneau and Michalet-Doreau, 1991). Protein degradability investigatons hast been relatively numerous during the past twenty years, However,

data about starch digestion in the rumen are rather scarce. For that reason, the objective of this investigation was to determine starch degradability in the rumen, on of eight concentrate feeds commonly used in diets for dairy cows in Yugoslavia using the in situ method.

MATERIAL AND METHODS

Bags were made from synthetic material of dimensions 140 x 90 mm, with an average pore size of 40 μm. Samples were ground in a hammer mill with a sieve size of 1 mm. Each feed was placed in five bags in each of two ruminally cannulated cows. Sample incubations in the rumen lasted for 2, 8, 16, 24 and 48 hours. The cows were in lactation and received a diet of meadow hay that met their nutritive needs.

Dry matter (DM) was determined by heating first at 60 ^{0}C and later at 100+5 ^{0}C. Starch was analyzed by the polarimetric method.

Degradability parameters were derived as constants in a function that made the best fift to in situ data. The function that best matched the experimental data was calculated by an iterative noninear least squares procedure based on Marquardt's algorithm. The starch degradability (SD) in the rumen was expressed by the exponential model of McDonald (1981):

$$SD = a + b\,[1-e^{-c(t-to)}]$$

where 'a' is the soluble fraction extrapolated from the exponential portion of the curve at zero time ('t'), 'b' was the degradable fraction, 'c' was a rate constant for 'b' expressed in % per hour and 't' was the lag phase (in hours), or the time at which degradation starts.

Efective degradability (ED) was calculated by the equation of McDonald (1981): le compariosn between feeds and with

$$ED = a + \frac{bc}{c + k}\, e\,[^{-(c+k)}t_o]$$

where 'k' represented the outflow rate from the rumen (0.05), and other parameters were the same. To enab
the findings of other authors results, all results were calculated with the same 'k' value.

RESULTS AND DISCUSSION

The content of DM end starch in the investigated feeds is given in Table 1.

Table 1. Dry matter and starch content in the investigated feeds, %

Feeds	Dry matter	Starch
Wheat bran	89.59	18.43
Maize meal	87.00	61.56
Oat meal	87.00	38.90
Soybean meal	89.51	6.50
Sunflower meal	89.03	1.60
Dried sugar beet pulp	90.97	23.91
Pea grain	87.00	43.48
Faba bean grain	90.00	37.50

Starch degradability of the investigated feeds is shown in Table 2. Comparative values obtained by other authors are shown in Tables 3 and 4. It is noticeable that the values differ and that for some feeds (wheat bran, maize grain) degradability was found to be lower, for some it was higher (oat grain, pea grain) and for only one feed (faba bean grain) was it near the value given by Nocek (1990).

Table 2. Starch degradability parameters and effective degradability (ED) in some concentrated fedds

Feeds	Degradability parameters				ED
	a	b	c	t_o	k=0.05
	%	%	%/h	h	%
Wheat bran	40.32	58.66	0.0848	0.30	75.76
Maize meal	2.29	72.74	0.0207	2.73	19.85
Oat meal	34.13	63.45	0.1270	2.84	61.67
Soybean meal	24.45	74.95	0.1186	–	77.17
Sunflower meal	11.88	88.12	0.0799	4.16	43.45
Dried sugar beet pulp	13.63	86.37	0.0548	5.27	39.63
Pea grain	52.74	45.42	0.1098	2.03	75.30
Faba bean grain	22.40	75.62	0.1040	2.26	58.46

For some feeds (soybean meal, sunflower meal, dried sugar beet pulp) it was not possible to find comparative values in the available literature. Protein degradability has received much more attention in the past few decades. However, it has recently become apparent that starch degradability in the rumen plays an important role in feed and energy utilization in ruminants. Microbial protein synthesis in the rumen largely depends on the energy supply

from starch. The more starch is degraded in the rumen, the larger the quantity of protein synthesized per unit of time. This is particularly important because it is known (Nocek, 1990) that starch utilization in the lower part of the ruminant gastrointestinal tract is limited.

Table 3. Starch degradability in some concentrate feeds according to Cerneau and Michalet-Doreau (1991) with k=0.05

Feeds	a	b	c	ED
	%	%	%/h	%
Barley grain	82.0	18.0	0.571	98.55
Maize grain	26.5	73.5	0.045	61.32
Oat grain	94.5	5.5	0.071	97.73
Pea grain	55.9	44.1	0.207	91.42
Wheat bran	82.8	16.8	0.254	96.84

A high starch degradability in the rumen is considered most appropiate for high producing dairy cows because it enables better utilization of energy from the feed. Therefore, efforts are being made to improve starch degradability in some feeds like sorghum or maize which have naturally a low starch degradability (Olivera et al., 1995, Moriven et al., 1995, Chen et al. 1995). This is usually achieved by heat processing (Arieli et al. 1995). In situ degradability of starch and other feed ingredients (fiber) was also used for maize hybrid selection on the basis of their availability to ruminants (Verbic et al. 1995).

Table 4. Starch degradability in some feeds as cited by Nocek (1990)

Feed	Faba bran	Maize grain	Oat grain	Pea grain	Wheat bran
ED, %	60.9	33.0	53.4	57.8	87.0

According to Nocek and Russel (1988) the presence of readily available carbohydrates, of which starch is usually the most abundant in the diet, is one of the key factors that control fermentation processes in the rumen. Therefore investigations of starch degradability are becoming more numerous and the results will be an important element in ruminant feed evaluation systems. It this investigation some preliminary results were obtained for feeds used for dairy cow nutrition. Starch degradability found for some feeds was within the expected range, while for others it was below it. It seems that, similarly to the siluation with protein degradability, it is very variable. This indicates that much

more investigation is needed to make definitive conclusions about starch degradability in the rumen.

CONCLUSION

Effective in situ starch degradability values of some feeds, using a theoretical ruminal outlow rate of 5% h were: wheat bran 75.8%, maize grain 19.9%, oat grain 61.7%, soybean meal 77.2%, sunflower meal 43.5%, dried sugar beet pulp. 39.6%, pea grain 75.3%, faba bean grain 58.5%. For some feeds (wheat bran, maize grain) degradability was lower, for some higher (oat grain, pea grain) and for only one feed (faba bean grain) was it near the values published earlier by other authors.

REFERENCES

1. *Arieil, A., Bruckental, I., Kadar, O., Sklan, D.* 1995. In-sacco disappearance of starch nitrogen and fat in processed grains. Animal Feed Science & Technology, 51 3-4: 287.
2. *Cerneau, P., Michalet-Doreau, B.* 1991. In situ starch degradation of different feeds in the rumen, Reproduction Nutrition Development. 31:72.
3. *Chen, K. H., Huber, J. T., Simas, J., Theurer, C. B., Yu, P., Chan, S. C., Santos, F., Wu, Z., Swingle, R. S., Depeters, E. J.,* 1995. Effect of enzyme treatment or steam-falking of sorghum grain on lactation and digestion in dairy cows. Journal of Dairy Science. 78: 1727.
4. *Chen, K. H., Huber, J. T., Theurer, C. B., Simas., J., Santos, F., Chan, S. C., Swingle, R. S.* 1995. Effect of substituting steam-flaked sorghum for concentrate on lactation and digestion in dairy cows Journal of Dairy Science. 78: 367.
5. *McDonald, I.* 1981. A revised model for the estimation of protein degradability in the rumen. Journal of Agricultural Science (Cambridge) 96: 252.
6. *Moniven, M. A., Weisbjerg, M. R., Hvelplund, T.* 1995. Influence of roasting or sodium hydroxide treatment of barley on digestion in lactating cows. Journal of Dairy Science. 78: 1115.
7. *Nocek, J. E., Russel, J. B.* 1988. Protein and energy as an integrated system. Relationship of ruminal protein and carbohydrate avalability to microbial synthesis and milk production. Journal of Dairy Science 71: 2070.
8. *Nocek, J. E.* 1990. Implication of manipulating starch site digestion in dairy catle. Proceeding of the Cornell Nutrition Conference. 44.
9. *Olivera, J. S., Huber, J. T., Simas, J. ., Theurer, C. B., Swingle, R. S.* 1995. Effect of sorghum grain processing on site and extent of digestion of starch in lactating dairy cows. Journal of Dairy Science. 78: 1318.
10. *Russel, J. B. O'Connor, J. D., Fox, D. G., Van Soest, P. J., Sniffen, C. J.,* 1992. The Cornell net carbohydrate and protein system for evaluating cattle diets. I. Ruminal fermentation. Journal of Animal Science 70: 3551.
11. *Sniffen, C. J., O'Connor, J. D., Van Soest, P. J., Fox, D. G., Russel, J. B.* 1992. The Cornell net carbohydrate and protein system for evaluating cattle diets: II. Carbohydrate and protein availability. Journal of Animal Science 70: 3562.
12. *Verbić, J. Stekar, J.M.A., Resnikcepon,* 1995. Rumen degradation characteristics and fiber composition of various morphological parts of different maize hybrids and possible consequences for breeding. Animal Feed Science & Technology. 54 (1-4): 133.

RAZGRADIVOST SKROBA NEKIH KONCENTROVANIH HRANIVA KOJA SE KORISTE U ISHRANI MLEČNIH KRAVA

D. ALEKSIĆ, G. GRUBIĆ, A. PAVLIČEVIĆ

SADRŽAJ

Razgradivost skroba u osam koncentrovanih hraniva koja se često koriste u ishrani mlečnih krava ispitivana je putem in situ metode na dve krave fistulisane na buragu. Istraživana hraniva i njihova efektivna razdraganost skroba pri brzini odliva iz buraga od 5% bila su: pšenične mekinje - 75,76%, prekrupa kukuruza - 19,85%, prekrupa ovsa - 61,67% sačma soje - 77,17%, sačma suncokreta - 43,45%, suvi rezanac šećerne repe - 39,63% zrno graška - 75,30%, zrno boba - 58,46%. Za neka hraniva (pšenične mekinje i prekrupa kukuruza) razgradivost skroba je bila niža, za neke je bila viša (prekrupa ovsa i zrno graška), dok je za jedno hranivo (zrno boba) vrednost bila bliska rezultatima koje su ustanovili drugi istraživači.