Journal of Animal and Feed Sciences, 14, Suppl. 1, 2005, 279–282

Effect of barley cultivar on the chemical composition and rumen degradability of dry matter, protein and starch*

P. Micek[1], Z.M. Kowalski and F. Borowiec

Agricultural University of Cracow,
Department of Animal Nutrition
Al. Mickiewicza 24/28, 30-059 Kraków, Poland

ABSTRACT

An *in situ* method was used to determine the effect of barley variety on effective rumen degradability (ERD) and degradability parameters of dry matter (DM), crude protein (CP) and starch. Winter varieties were characterized by higher structural carbohydrate and lower CP contents. Differences in degradability parameters between individual varieties were shown. In general, spring cultivars, compared with winter ones, had significantly ($P<0.01$) higher ERD of DM (83.3 vs 78.8%). With the exception of Rodion, spring cultivars also had higher ERD of CP and starch. Among winter cultivars, two-line cultivars had lower ERD of CP and starch.

KEY WORDS: barley, cultivar, grain, chemical composition, ruminal degradability

INTRODUCTION

Cereal grains differ not only in their chemical compositions but also in the rate and extent of fermentation in the rumen (McAllister et al., 1993). The variability is particularly evident for barley, which is an important feed grain for ruminants. The nutritive value of barley lies primarily in its energy value based on the starch content in the grain, with protein being of secondary importance. Numerous barley cultivars on the market need to be evaluated before they can be successfully formulated into dairy and beef cattle rations. The objectives of our study were to examine the chemical composition of different barley cultivars as well as the rate and extent of their dry matter, crude protein and starch degradability in the rumen.

* Supported by the State Committee for Scientific Research, Grant No. 2 P06Z 001 27
[1] Corresponding author: e-mail: rzmicek@cyf-kr.edu.pl

MATERIAL AND METHODS

Five winter cultivars (Gregor, Gil and Sigra, multiline; Bombay and Tiffany, two-line), four spring cultivars (Stratus and Rudzik, brewery; Rodos and Rodion; fodder) and one naked spring cultivar (Rastik) were harvested in the year 2002. The chemical composition of grain was determined using standard methods (AOAC, 1995), starch by the method of Faisant et al. (1995) and NDF, ADF and ADL by Goering and Van Soest (1970). *In situ* ruminal degradability was determined by the method of Michalet-Doreau et al. (1987), using 2 rumen fistulated heifers fed standard diets (meadow hay and concentrate mixture). Approximately 3 g of samples (ground to pass through a 1.5 mm screen) were placed in nylon bags (pore size 46 μm; Ankom Co, Fairport, NY) yielding a ratio of sample mass per bag area of 27 mg cm^{-2}. The bags were introduced into the rumen at the same time and pulled out at different times (0, 2, 4, 8, 16, 24, 48 and 72 h). The effective rumen degradability (ERD) and the digestibility rate constants (A, B, C) were calculated according to Ørskov and McDonald (1979) at a ruminal outflow (k) of 0.06 h^{-1}. The data were subjected to one-way analysis of variance using GLM procedure of SAS (SAS, 1995).

RESULTS AND DISCUSSION

Winter cultivars were characterized by lower CP (99 vs 121 g kg^{-1}) and higher ADF (106 vs 130 g kg^{-1}DM) contents in comparison with spring cultivars (Table 1). The highest CP and starch contents were found in the naked cultivar, Rodion (141 and 741 g kg^{-1}DM, respectively).

Winter cultivars had significantly ($P<0.01$) lower ERD of DM than spring cultivars (78.8 vs 83.3%; Table 2) as observed by Żebrowska et al. (1997).

Table 1. Chemical composition of barley cultivars, g kg^{-1}DM

Item	Winter cultivars*						Spring cultivars**					Naked
	1	2	3	4	5	mean	6	7	8	9	mean	
CP	96	95	124	106	108	106	132	112	136	140	130	141
NDF	234	231	272	218	221	235	251	223	246	215	234	222
ADF	96	75	88	62	73	79	41	43	47	79	53	36
Starch	672	606	554	670	727	651	623	677	653	643	649	741

* 1 - Gregor, 2 - Gil, 3 - Sigra, 4 - Bombay, 5 - Tiffany

** 6 - Stratus, 7 - Rudzik, 8 - Rodos, 9 – Rodion

Analysis of DM degradability parameters indicates that the difference between spring and winter cultivars in ERD of DM was probably caused by the structural carbohydrate content. The higher ERD of DM in spring cultivars may

Table 2. *In situ* DM, CP and starch degradability parameters of barley cultivars

Cultivar	Dry matter				Crude protein				Starch			
	A %	B %	C % h^{-1}	ERD %	A %	B %	C % h^{-1}	ERD %	A %	B %	C % h^{-1}	ERD %
Winter												
Gregor	39.2	48.4	0.295	79.4	46.4	47.4	0.162	81.0	92.3	4.7	0.063	92.3
Gil	37.0	48.8	0.451	80.0	44.3	50.0	0.245	84.4	48.5	51.9	0.591	94.7
Sigra	30.0	54.0	0.325	75.6	34.2	59.7	0.221	81.1	93.7	4.8	1.442	93.8
Bombay	32.5	57.4	0.290	80.0	39.1	56.6	0.110	75.7	90.9	8.4	1.136	91.4
Tiffany	37.1	52.6	0.232	78.8	37.9	57.0	0.121	75.9	89.4	10.5	0.899	90.5
mean	35.1	52.2	0.319	78.8	40.4	54.1	0.172	79.6	82.9	15.9	0.826	92.5
SD	3.8	3.8	0.081	1.8	4.9	5.2	0.060	3.8	19.3	19.8	0.529	1.7
Spring												
Stratus	37.5	52.0	0.517	83.9	41.4	53.4	0.259	84.6	85.3	14.0	1.005	95.5
Rudzik	38.9	52.4	0.625	86.7	44.6	51.6	0.295	87.4	92.0	7.9	1.292	96.2
Rodos	31.8	57.5	0.545	83.5	38.8	57.1	0.201	82.2	94.8	2.3	1.726	95.9
Rodion	32.5	57.5	0.260	79.1	49.0	47.5	0.171	65.3	41.2	57.3	0.608	91.5
mean	35.2	54.8	0.487	83.3	43.4	52.4	0.231	79.9	78.3	20.4	1.658	94.7
SD	3.6	3.1	0.158	3.2	4.4	4.0	0.056	10.0	35.6	35.6	1.697	2.2
P[1]	NS	NS	*	**	NS	NS	NS	NS	NS	NS	*	*
SE	0.82	0.85	0.03	0.79	1.15	1.09	0.02	1.54	6.18	6.22	0.32	0.49
Spring - naked cultivar												
Rastik	36.4	60.0	0.376	88.1	26.6	71.2	0.149	75.2	88.1	11.2	1.020	92.2

[1] effect of winter vs spring cultivars : NS - non significant, * $P<0.05$, ** $P<0.01$

be also caused by more degradable starch (ERD starch 94.7 vs 92.5%), although we found very high variation in starch degradability parameters. The reasons for the exceptionally low A values for cultivars Gil and Rodion, and the high variability of C values are unclear. Except for Rodos (ERD of CP=65.3%), the two-line cultivars (75.8%) and the naked cultivar (75.2%), the ERD of CP of other cultivars was relatively high and exceeded 81%. The very low solubility of CP in the naked cultivar (A=26.6%) is noteworthy. The data reported by McAllister et al. (1993) suggest that structural components within the endosperm, rather than the protein matrix and properties of the starch granules themselves, are responsible for the differences in the ruminal digestion of barley.

CONCLUSIONS

Chemical composition as well as rumen degradability parameters of individual barley cultivars are vary variable. In general, winter cultivars have higher structural carbohydrate contents, which is responsible for the lower availability of DM, crude protein and starch in the rumen.

REFERENCES

AOAC, 1995. Official Methods of Analysis, Association of Official Analytical Chemists. 16th Edition. Arlington, VA

Faisant N., Planchot V., Kozlowski F., Pacouret M.P., Colonna P., Champ M., 1995. Resistant starch determination adapted to products containing high level of resistant starch. Sci. Aliment. 15, 83-89

Goering H.K., Van Soest P.J., 1970. Forage Fiber Analysis (Apparatus, Reagents, Procedures, and Some Applications). Agric. Handbook No. 379. ARS-USDA. Washington, DC

McAllister T.A., Phillippe C., Rode L.M., Cheng K.J., 1993. Effect of the protein matrix on the digestion of cereal grains by ruminal microorganisms. J. Anim. Sci. 71, 205-212

Michalet-Doreau B., Verité R., Chapoutot P., 1987. Methodologie de mesure de la degradabilité in sacco de l'azote des aliments dans le rumen. Bull. Tech. C.R.Z.V., Theix 69, 5-7

Żebrowska T., Długołęcka Z., Pająk J.J., Korczyński W., 1997. Rumen degradability of concentrate protein, amino acids and starch, and their digestibility in the small intestine of cows. J. Anim. Feed Sci. 6, 451-470

STRESZCZENIE

Wpływ odmiany jęczmienia na skład chemiczny oraz rozkład w żwaczu suchej masy, białka i skrobi

Celem przeprowadzonych badań było określenie wpływu odmiany jęczmienia na skład chemiczny oraz na parametry rozkładu w żwaczu suchej masy, białka i skrobi ziarna. Stwierdzono znaczne różnice pomiędzy odmianami zarówno w składzie chemicznym jak i efektywnym rozkładzie w żwaczu. Odmiany ozime zawierały więcej węglowodanów strukturalnych, natomiast mniej białka ogólnego. Efektywny rozkład (ERŻ) suchej masy w żwaczu (83,3 vs 78,8%) odmian jarych był statystycznie wyższy ($P<0,01$) niż odmian ozimych z wyjątkiem odmiany Rodion. U odmian jarych także wyższy był ERŻ białka i skrobi. Spośród odmian ozimych jęczmienia, odmiany dwurzędowe miały niższy ERŻ zarówno białka jak i skrobi.