

Studies of Barley Feed Quality

Relative to corn, barley is considered to be a ‘hot’ grain for dairy cattle because it is very rapidly degraded in the rumen. In practice, this means that animals fed high levels of barley in their diets are more susceptible to digestive upsets, off-feed problems, acidosis, laminitis and liver abscesses than cattle fed corn.

Over the past several decades, many cattle feeding trials have been conducted at the University of Alberta where barley has been the primary source of fermentable carbohydrate. Routine analyses of the barley samples used in those trials have demonstrated significant variation in nutrient levels and digestibilities. On the basis of these random observations, we have recently completed a series of systematic studies aimed at identifying specific barley varieties having the most desirable nutritional characteristics for dairy cattle.

Nutritional diversity of barley varieties

Initially, samples of 60 different barley cultivars were selected by plant breeders at the Lacombe Crop Development Centre. Selections included samples of 2 row, 6 row, feed, malt, hulled and hullless types. Samples were ground through a 2 mm screen then subjected to chemical analysis and to incubation in small nylon bags in the rumen for measurement of rate and extent of ruminal digestion.

Table 1 summarizes the diversity in nutritional characteristics among these cultivars and compares these with average values for corn. Table 2 shows mean rumen dry matter (DM) degradability values for each of the six types.

There were no significant differences between 2 row and 6 row cultivars (see article **1F2** for an explanation of statistical significance). Feed cultivars had significantly higher soluble but lower degradable DM values than malt cultivars. Hulled samples had significantly lower soluble and degradable DM values than hullless samples.

	BARLEY VARIETIES			CORN
	MIN	MAX	MEAN	MEAN
STARCH, % of DM	48.3	62.5	55.2	65.5
CRUDE PROTEIN, % of DM	10.8	16.2	13.3	10.0
RUMEN DRY MATTER DEGRADABILITY (DMD):				
SOLUBLE DM, %	33.4	56.4	51.0	37.0
DEGRADABLE DM, %	34.1	60.2	41.7	61.1
DEGRADATION RATE, %/hr	20.0	62.4	37.3	10.9
EFFECTIVE DMD, %	73.8	89.0	83.6	69.9

Table 1 : Minimum, maximum and mean values for nutritional characteristics of 60 barley cultivars in comparison with mean values for corn. Page 2 sidebar explains terminology.

To determine whether nutritional characteristics could be correlated with simple measurements in the field, we examined the relationships between degradability and two measures of kernel size: bulk density (kg/hL) and 1000 kernel weight. High bulk densities (high bushel weights) were associated with high soluble and low degradable DM levels. High 1000 kernel weights reflected both high soluble and high degradable DM levels.

These initial results allowed us to identify 11 of the most promising varieties for further study. Test plots of these 11 varieties were planted the following spring and the grain harvested to provide sufficient sample volumes for detailed evaluation of nutritional value.

	2 ROW	6 ROW	FEED	MALT	HULLED	HULLESS
RUMEN DRY MATTER DEGRADABILITY (DMD):						
SOLUBLE DM, %	47.9	45.4	47.8	↔s↔ 45.4	43.6	↔s↔ 49.6
DEGRADABLE DM, %	46.3	47.8	46.0	↔s↔ 48.1	45.4	↔s↔ 48.7
DEGRADATION RATE, %/hr	39.0	39.5	40.4	38.2	41.3	37.3
EFFECTIVE DMD, %	84.4	83.5	84.2	83.6	80.0	87.8

Table 2 : Comparison of rumen dry matter degradabilities among barley cultivar types. ↔s↔ indicates statistically significant differences between mean values for cultivars of each type.

CULTIVAR	TYPE	DENSITY (kg/hL)	1000 WT (g)	CP (%)
Guardian	H - F - 2	59.9	46.0	12.2
Seebe	H - F - 2	61.7	46.5	12.3
Noble	H - F - 6	72.6	38.5	11.1
Tankard	H - F - 6	57.4	38.5	15.0
Oxbow	H - M - 2	55.1	42.5	11.4
Duel	H - M - 6	62.2	44.2	14.2
Brier	H - M - 6	59.7	41.0	10.2
Richard	HL - F - 2	73.8	40.5	13.2
Phoenix	HL - F - 2	73.5	34.0	12.1
Candle	HL - F - 2	59.4	39.0	13.7
Falcon	HL - F - 6	70.0	29.5	13.4

Table 3 : Cultivars selected for detailed evaluation.
 Type codes are: H - hulled, HL - hullless, F - feed, M - malt, 2 - 2 row, 6 - 6 row. 1000 WT is 1000 kernel weight; CP is crude protein.

Effect of particle size

To evaluate the influence of particle size on digestion characteristics, samples of 3 cultivars (Duel, Richard and Seebe) were ground through 2, 4 or 6 mm screens before incubation. Results are shown in table 4. Particle size had no significant effect on rate of DM degradation. Soluble DM fraction and effective DM degradability increased and degradable DM decreased significantly with fineness of grind. These results clearly demonstrate that standardization of sample particle size is necessary for valid comparison of results from different laboratories.

Evaluation of selected cultivars

The 11 selected cultivars are listed in table 3, along with their morphological and physical characteristics and crude protein contents. Their DM degradability characteristics are compared in figure 1, together with those of single samples of corn and wheat.

The hullless variety, Candle, had the lowest DM degradation rate among the cultivars tested as well as one of the highest effective DMD values and a relatively high crude protein content (table 3). Assuming its agronomic characteristics (yield, suitability to site, etc.) are favourable, Candle might be a good variety to grow for feeding to lactating cows.

The wide variability in digestive characteristics demonstrated in these studies indicate the potential for further genetic selection as a means of enhancing the nutritional quality of barley for dairy cattle.

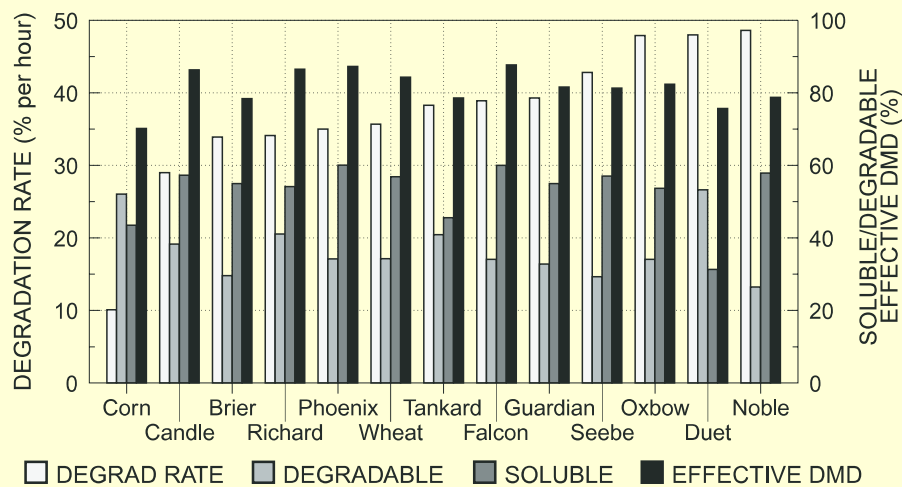


Figure 1 : Dry Matter degradability characteristics of 11 selected cultivars of barley and one each of corn and wheat, ranked by DM degradation rate.

	SCREEN SIZE		
	2 mm	4 mm	6 mm
RUMEN DRY MATTER DEGRADABILITY (DMD):			
SOLUBLE DM, %	49.9	41.7	27.1
DEGRADABLE DM, %	42.4	50.8	63.6
DEGRAD RATE, %/hr	27.1	28.6	23.2
EFFECTIVE DMD, %	79.4	77.8	68.1

Table 4 : Effects of grinding barley through 3 different screen sizes on rumen DM degradability.

EXPLANATION OF TERMINOLOGY

SOLUBLE DM represents a fraction of feed DM which is immediately available for breakdown in the rumen. DEGRADABLE DM is broken down at the DEGRADATION RATE shown. SOLUBLE DM + DEGRADABLE DM is the total amount available for rumen breakdown. EFFECTIVE DMD is an estimate of the amount of DM which will actually be broken down in the rumen before the undegraded fraction escapes into the lower digestive tract.

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