Research Facts
Research & Technology Development for the Canadian Beef Industry

Predict rumen fermentation of processed barley grain

by Alberta Crop Industry Development Fund

Project Title:	
Develop an accurate and concise in vitro procedure to predict feeding value of processed barley grain	
Project Code:	2012F070R
Completed:	*August 2015*

Researchers:

WenZhu Yang, PhD (Agriculture and Agri-Food Canada, Lethbridge) wenzhu.yang@agr.gc.ca
WenZhu Yang, PhD (AAFC Lethbridge), Tim McAllister, PhD (AAFC, Lethbridge), Mary-Lou Swift, PhD (Alberta Agriculture and Rural Development, Lethbridge), Darryl Gibb, PhD (Feedlot consulting), Uchenna Anele, PhD (NSERC PDF)

Published:

- Anele, U.Y., Refat, B., Swift, M. L., He, Z. X., Zhao, Y. L., McAllister, T. A. and Yang, W. Z. 2014. Effects of bulk density, precision processing and processing index on in vitro ruminal fermentation of dry-rolled barley grain. Anim. Feed Sci. Technol.
- Zhao, Y.L., S.M. Yan, Z.X. He, U.Y. Anele, M.L. Swift, McAllister, T.A. and Yang, W.Z. 2015. Effects of volume weight, processing method and processing index of barley grain on in situ digestibility of dry matter and starch in beef heifers. Anim. Feed Sci
- Yang, W. Z., M. Oba, M. L. Swift and T. A. McAllister. 2014. Variation in response to processing, in vitro gas production and fermentation of western Canadian feed barley. Can. J. Anim. Sci. 94:725–729.

Background:

Rate of starch digestion of barley grain in the rumen determines ultimately the amount of starch availability in the rumen and the incidence of rumen acidosis. It was reported a wide divergence in the extent and rate of starch digestibility (20 to 70% at 4 h of in vitro incubation) of commercial feed barley samples collected from different locations and year although the samples were processed the same. These barley samples have also substantial variability of physical and chemical constituents, and in vitro dry matter digestibility. It emphasizes the challenge in precision feeding of commercial feed barley, and suggests a need to develop a rapid prediction model for predicting feeding value of barley grain at farm level. High starch digestion rate combining with high-grain feeding suggests high risk of rumen acidosis which causes erratic feed intake, reduced performance, and liver abscesses. Barley variety and individual grain samples are known to vary widely in their capacity to cause rumen acidosis. A model was developed by Australian scientists to predict the ‘hotness’ of individual grain samples for ruminants and their potential to cause ruminal acidosis. Further study showed that there was a strong relationship between the estimated hotness of a grain and its ability to cause acidosis. However, the acidosis index requires a number of measurements including in sacco starch disappearance, in vitro rates of total acid and lactic acid production, and starch and fibre composition of grains.

Objectives:

Determining starch digestion rate and global digestibility of grain to develop a rapid and concise in vitro procedure to predict the feeding value of processed barley grain.

Determining in vitro and in situ starch digestion rate and fermentation acid production to develop an acidosis index to rapidly predict the ability of a grain potentially causing rumen acidosis in finishing cattle

What They Did:

A large pool of barley samples with a wide range in bulk density and starch content were collected monthly during 18 months from ten commercial feedlots in south Alberta; the samples were dry-rolled differently (i.e., multiple versus single roller setting).

The processed barley samples were incubated in the rumen at various incubation times using in vitro batch culture or in situ technique, and gas production and rate of dry matter and starch digestion were measured.

What They Learned:

There was considerable variability of physical and chemical constituents and in vitro dry matter digestibility of commercial feed barley samples collected from different locations and year. Applying different processing method resulted in clear differences in in vitro barley digestion.

Manipulating processing method using precision processing (PP) and processing index (PI; 75 versus 85%) can effectively alter ruminal digestion kinetics of dry-rolled barley grain. The digestion rate can be better predicted from chemical composition of PP barley samples. Results also showed that bulk density (or bushel weight) and PP were better in predicting rate of digestion than PI. It indicates that using only PI as a measurement for extensity of grain processing may not be reliable if the grain kernels are highly variable in size.

From in situ data, the results demonstrated that the PP approach and manipulating degree of processing, expressed as PI, are effective ways to optimize rumen digestion of barley grain. In situ rate of DMD was particularly correlated to the particle size distribution of processed grain and the amount of fine particles were the primary predictor.

Besides of bulk density, PP and PI, starch content of barley grain had significant effect on the rate of dry matter and starch digestion in vitro or in situ.

A model to predict acidosis index of barley grain ($-0.7826 + 2.5536 \times DMD6$; $R^2 = 90.5\%$, $P<0.01$) was developed based on dry matter digestion after 6 h of incubation (DMD6) in a reduced buffer in vitro system. The model was evaluated with 3 independent datasets generated from our previous in vitro studies. The rankings of the acidosis index of barley samples by the present model and those calculated from the Australian method were strongly related.

What It Means:

The observed variability of barley composition and in vitro digestion and its correlation suggest a need to develop a concise and accurate in vitro method for predicting feeding value of barley grain.

The consistent correlation between in situ rumen digestion rate of dry matter and the fine particle fraction of processed barley suggests that a method to predict rumen digestion of barley may be developed based on measuring the amount of fine particle of processed barley. Measuring the proportion of fine particles in processed barley grain can be used as an alternative to processing index for quantifying the degree of processing in feed mill since the processing index is affected by the method selected for processing.

The developed model to predict acidosis index of grain, which is based on DMD after 6 h of incubation in a reduced buffer in vitro system has the potential to predict acidosis risk and to rank different barley samples based on their acidotic risk.

Therefore, applying the prediction model to quickly determine the feeding value of processed barley will allow producers to optimize processing and modulate starch fermentation in the rumen for improving animal health and performance. Predicting the ability of processed individual grain samples to cause rumen acidosis will allow producers to reduce the incidence of rumen acidosis.

Proudly Funded By:

This research has been funded in part thru the Alberta Livestock Feeding Initiative. In 2010, ALMA provided $8 million to start the Livestock Feeding Initiative program that ACIDF administers. The strategic priorities are:

1. “Feed Utilization” The more efficient utilization of feed grains by the livestock sector.
2. “Feed Value” technology that identifies feed grain’s livestock performance attributes for both growers and feeders.
3. “Innovation in Breeding” Increased investment in public and /or private research and plant breeding dedicated to feed grain.

Further information is available at www.acidf.ca/feeding or e-mail at info@acidf.ca.