Investigating effect of barley grain hardness on ruminal digestion in cattle

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OBJECTIVE

This research is being conducted to determine if varying the grain hardness of Barley will have an effect on the rate of starch digestion in the rumen.

BACKGROUND

- Barley grain hardness is determined by the starch proteins hordoindoline (HIN) A, HIN-B1 and HIN-B2.
- Soft barleys are the result of all HIN genes in active form and bound to the starch granules.
- Currently there are no soft barleys with most varieties ranging in hardness from 45-75.
- Comparing corn and barley ruminal starch digestion, McAllister et al. (1993) concluded that structural components associated in or within the endosperm were responsible for the differences in starch digestion.
- Wheat grain hardness is determined by the degree adhesion between starch granules and the protein matrix, regulated by the protein complex friabilin, Swan et al. (2006)
- The Barley variety Monte Cristo lacks Hinb-2 since it carries a stop codon (Theor Appl Genet (2010) 120:519-526) and this allele is associated with an increase in SKCS by 15 units.

MATERIALS AND METHODS

- Monte Cristo was crossed with Morex, to create BC2:F5 lines in Morex
- 16 homozygotes of the BC2:F5 lines as well as 2 parents and 2 controls were grown in field conditions in replicated single row plots during the 2014 growing season.
- These lines were measured for Single Kernel Hardness as well as other quality parameters.
- Replicated lines as well as a control were then milled to result in a coarse and a fine grind.
- Mean particle size was then calculated across the different milling treatments.
- Starch content and Acid Detergent Fiber(ADF) were then measured.
- InSitu Dry Matter Digestibility(ISDMD) was completed on March 23rd, and utilized a 3 hour incubation period.
- ADF and Starch content will be measured on the post ISDMD material over the course of the next month.

RESULTS

- SKCS results revealed that there was a difference of 15 units between the mutant and wild types.
- Mean particle size was calculated, with results showing that there was a difference in particle size across the coarse grind, with no difference being seen in the fine grind.
- No statistical difference was seen between pre-digestion starch content in the mutant and wild types.
- Initial mutant and wild type ADF values resulted in a P-value <.01.
- There was a difference in digestibility across the mutant and wild type lines in the coarse ground samples but was not seen in the fine grind.

Variety	Seed Size	SKCS Values	Coarse Grind Particle Size, um	Fine Grind Particle Size, um	Initial Starch Content	Initial ADF Content
Steptoe	2.73	54.85	2.02	0.76	59.14	10.27
Hockett	2.72	51.71	1.93	0.76	69.08	7.54
Harrington	N/A	N/A	1.89	0.75	59.34	4.47
Morex	2.71	55.49	1.96	0.75	63.49	6.95
Monte Cristo	2.72	47.52	1.93	0.76	44.95	8.29
Mutant	2.69	74.59	1.98	0.76	62.27	7.51
WT	2.77	59.22	1.92	0.76	60.33	5.98
Mutant vs wt *P*-value	0.023	0.000	0.040	0.461	0.219	0.008

Table 1. Results of SKCS, Particle Size, Starch and ADF values

Variety	Coarse Grind %ISDMD	S.E.	Fine Grind %ISDMD	S.E.
Steptoe	12.21	6.83	39.39	12.45
Hockett	17.41	5.31	37.21	9.10
Harrington	13.07	7.76	35.01	12.62
Morex	13.69	5.40	36.74	9.30
Monte Cristo	22.68	8.58	36.34	12.00
Mutant	19.10	3.83	42.48	3.92
WT	17.02	3.80	42.06	5.50
Mutant vs wt *P*-value	0.05		0.39	

Table 2. Results of In Situ Dry Matter Digestibility.

CONCLUSIONS

This data has shown that varying the degree of grain hardness in barley does result in a change in the level of In Situ Dry Matter Digestibility in beef cattle. More research in this area is needed to determine rate of starch digestion that occurred in the rumen over the course of the incubation period, and determine if hardness does have an affect on the rate of starch disappearance.

Figure 3. Removing In Situ bags from rumen via the cannulation.

Figure 4. Ankom 2000 Fiber analyzer used to measure ADF.

CITATIONS

- McAllister, T.A., R.C. Phillippe, L.M. Rode, and K.J. Cheng. 1993. Effect of the protein matrix on the digestion of cereal grains by ruminal microorganisms. J.Anim. Sci. 71:205-212.
- Swan, C.G., J.G.P. Bowman, J.M. Martin, and M.J. Giroux. 2006. Increased puroindolines levels slow ruminal digestion of wheat (*Triticum aestivum* L.) starch by cattle. J. Anim. Sci. 84:641-650.