Grain Processing Differences between Barley Varieties for Cattle

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Key Words: barley, varieties, cattle, processing, fines

Abstract

Barley is fed to cattle as a concentrated energy source. Before feeding, the grain is cracked (processed) to expose the endosperm to rumen fermentation. Processing disrupts the endosperm starch-protein matrix and produces fine particles (fines). Fines may lead to acidosis and liver abscesses in cattle. In 2004, nine Western Canadian barley varieties, including seven feed and two malt varieties, were analyzed for fines produced after three processing treatments: dry with minimal processing, dry with excessive processing, and tempered with excessive processing. Fines were measured as the percentage of processed sample falling through a 1.40 mm brass sieve. Grain hardness, using Single Kernel Characterization System (SKCS), and protein content, using Near Infrared Transmittance (NIT) were analyzed to identify their relationship with fines production. Varieties differed in % fines produced after rolling with variety by processing interaction being present ($P<0.05$). However, Xena and CDC Dolly produced significantly less fines for all processing methods and CDC Trey and CDC Bold produced more ($P<0.05$). Varieties with more protein produced fewer fines when minimally dry rolled, with the exception of Xena ($P<0.05$). Grain hardness and protein content appear related to processing characteristics; however, correlations were not significant. Grain hardness was significantly correlated with protein ($R=0.77$, $P<0.05$).

Introduction

In Western Canada, barley grain is fed to cattle as a concentrated energy source. It is highly digestible and contains more protein than corn. Before feeding, barley is rolled to crack the grain and expose the starchy endosperm. The process (rolling) crushes kernels between two corrugated rollers. The extent of processing depends upon the separation (gap) distance between the rollers. Increased processing improves animal gain and feed efficiency. However, processing also increases dust and small particles referred to as “fines”. These result from the disruption of the endosperm starch-protein matrix by which starch particles are dislodged from the surrounding protein.

Fines pose a health risk to cattle by increasing incidence of rumen acidosis and liver abscesses. Some producers will reduce fines by tempering grain before processing. Wang et al. (2003) reported that tempered barley improved cattle performance only when compared to over-processed dry feed with excessive fines. Tempering adds labour and management costs, thus it would be beneficial for producers if tempering was not required.

The purpose of this study was to evaluate the processing characteristics of several Western Canadian barley varieties by measuring fines produced after rolling. Grain protein content and

grain hardness were also measured to determine if these traits were related to the degree of endosperm disruption.

Materials and Methods

Seven feed and two malt barley varieties were grown at four sites in Western Canada during 2004 at Saskatoon (two sites), Wakaw, and Brandon. To provide seed of relatively uniform size and shape, grain samples were screened by sieving such that only seed passing through a 3.10 X 18.75 mm slotted sieve and those remaining on a 2.9 X 18.75 mm slotted sieve were retained for rolling.

Using a small Sven Roller Mill (Apollo Industries, Saskatoon, SK) with 8-inch diameter rolls and a 1.5 horsepower motor, fifty-gram grain samples were rolled as follows:

1. Minimal-processed Dry (roller gap size 1.7mm, 9-12% grain moisture),
2. Over-processed Dry (roller gap size 1.3mm, 9-12% grain moisture),
3. Over-processed Tempered (roller gap size 1.3mm, 15-18% grain moisture).

Tempered samples were prepared by mixing three mL of water with the 50-gram sample and refrigerating for 36 hours before rolling.

Fine Particle Size Analysis

Rolled samples were separated by sieving using a W.S. Tyler Sieve Shaker system. Samples were shaken for 3 minutes. Fines were determined as the percent of the sample by weight that passed through a 1.40 mm brass wire sieve.

SKCS Grain Hardness and Moisture

Three hundred seed per sample were evaluated using the Perten Single Kernel Characterization System (SKCS). Grain hardness values (0 – 100) indicate kernel crushing force required. Higher values indicate harder grain. SKCS moisture values indicated that samples were of uniform moisture within a site, with minor differences between sites (data not shown).

NIT Percent Protein

Near Infrared Transmittance (NIT) was used to estimate grain protein based on the 2004 Crop Development Centre hulled barley NIT protein calibration using a Infratec Food and Feed Analyzer.

Results

There were differences between varieties for % fines produced after rolling (Table 1). While variety by processing interaction was evident, Xena and CDC Dolly produced less fines and CDC Trey and CDC Bold produced more fines for all processing methods. Tempering appeared to affect fines production; however, varieties were affected differentially.

McLeod required the greatest crushing force, followed by Valier and Xena, and these varieties produced fewer fines when minimally processed dry. CDC Bold required the least crushing force and produced greater % fines. However, CDC Dolly, which required average crushing

force, had the least fines for all processing methods. Varieties with more protein produced fewer fines when minimally dry rolled, with the exception of Xena.

While kernel hardness and protein content appear related to processing characteristics, correlations were not significant (Table 2). However, kernel hardness was significantly correlated with protein (R=0.77, P=0.05).

Table 1. Percent Fines after Processing Treatment, SKCS Kernel Hardness, and NIT % Protein of nine Western Canadian Barley Varieties at four locations, 2004.

		PROCESSING METHOD				
		Minimal Dry	Over Dry	Over Tempered	SKCS Kernel	NIT
Variety	Use	% Fines (<1.40 mm sieve)			Hardness*	% Protein
CDC Helgason	Feed	4.4 a	14.3 abc	6.9 c	46.9 d	11.5 abc
Xena	Feed	4.5 ab	14.3 ab	5.9 a	51.0 bc	11.2 bcd
Valier	Feed	4.7 abc	14.1 a	6.7 c	53.3 b	11.6 abc
CDC Dolly	Feed	4.8 abcd	14.0 a	6.0 ab	49.4 cd	11.4 abc
Newdale	Malt	5.0 abcd	15.2 cde	6.6 bc	46.8 d	11.8 ab
McLeod	Feed	5.0 abcd	15.5 def	7.2 cd	57.5 a	11.9 a
CDC Copeland	Malt	5.1 bcd	15.5 def	7.8 de	40.5 e	10.8 de
CDC Trey	Feed	5.4 de	16.1 efg	7.9 e	47.9 cd	11.3 bcd
CDC Bold	Feed	5.8 e	17.0 g	8.3 e	38.8 e	11.1 cd

Means in same column followed by same letter are not significantly different P=0.05.

*SKCS Kernel Hardness 0-100 with 100=hardest.

Conclusions

Varieties differ in fines produced during processing. CDC Trey and CDC Bold produced more fines than other varieties while Xena and CDC Dolly produced the least fines. Differences in fines appear related to grain hardness and protein content.

References

Wang, Y., D. Greer, and T.A. McAllister. 2003. Effects of moisture, roller setting, and saponin-based surfactant on barley processing, ruminal degradation of barley, and growth performance by feedlot steers. J. Anim. Sc. 81:2145-2154.