
Low-lignin Hull in Oat

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Abstract

The use of whole oat in feed rations is restricted due to low digestibility of the hull. AC Assiniboia hulls have decreased acid detergent lignin (ADL) content. AC Assiniboia was crossed with OT 775 and the resulting lines were measured for ADL content. The ratio of F_{4,5} lines with low to normal ADL concentration fit a 1:1 genetic ratio. Indicating that the low-lignin trait is controlled by a single major gene. ADL concentration was correlated with hull colour and acid detergent fiber concentration. ADL concentration was not correlated with the protein or fat concentration of the groat. Simple inheritance of the low-lignin trait indicates that it can be incorporated into the oat breeding program. Furthermore, ADL concentration is not correlated with groat fat so a cultivar with a low-lignin hull and high fat groat can be developed.

Introduction

The limited digestibility of oat hulls restricts the use of whole oats. Lignin content is the major determinant of hull digestibility (Crosbie *et al.*, 1985). Variation in hull lignin content does exist. Studies by Welch *et al.* (1983) and Crosbie *et al.* (1984) identified genotypes with decreased hull lignin content. Recently, Thompson *et al.* (2000), evaluated the hull composition and digestibility of 10 western Canadian varieties. One cultivar (AC Assiniboia) contained ~ 75% less acid detergent lignin (ADL) and had increased invitro dry matter digestibility. The increased digestibility of AC Assiniboia hulls makes them equivalent in quality to good barley straw.

If the low-ADL trait from AC Assiniboia is simply inherited it could be combined with a high fat groat to obtain a high energy, highly digestible whole oat feed. The main objective of the current study was to determine the inheritance of hull ADL. The relationship between ADL, groat percentage, groat protein and fat concentration was also evaluated. AC Assiniboia has a brown hull. Low-lignin mutants in other crops have been associated with a reddish-brown phenotype (Halpin *et al.*, 1998; Gupta, 1995). The oat industry prefers white-hulled oats, so the relationship of hull colour and ADL concentration was also investigated.

Materials and Methods

Plant Material

Plant material for this study consisted of 103 recombinant inbred lines (RIL's) from AC Assiniboia X OT 775. The lines were grown at Saskatoon in 2000 and 2001. All lines

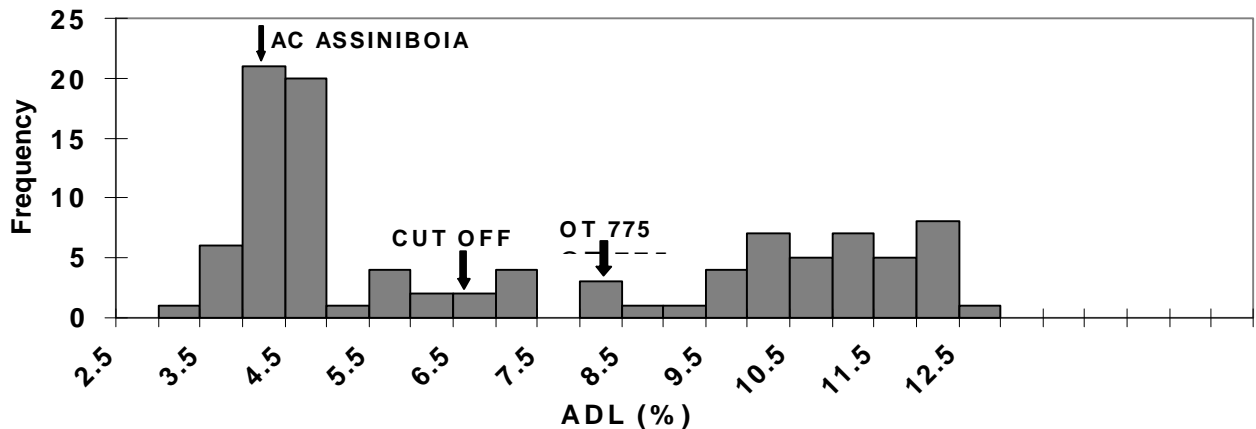
were planted as replicated hill plots using a randomized complete block design, which included regularly placed check varieties.

Acid detergent fiber (ADF) and acid detergent lignin (ADL) content was determined for all samples using an ANKOM²⁰⁰ Fiber Analyzer. The ADF and ADL procedures were performed according to manufacturer's instructions (ANKOM, 1998).

Protein and fat concentration of the groat was estimated using near-infrared transmittance spectroscopy. Groat percentage was determined by dehulling 50g samples in a Codema dehuller and dividing the weight of the resulting groats by that of the original sample. Hull colour (L, a and b values) were measured on whole oat samples using a HunterLab MiniScan Spectrophotometer.

Results and Discussion

The first 3 replicates from 2000 have been analyzed for all traits. AC Assiniboia had significantly lower ADL concentration (4.15%) compared with OT 775 (8.21%) and the check varieties (8.32-9.90%). The ADL values have not been corrected for ash content and are therefore higher than reported by Thompson *et al.* (2000). Goodness of fit to selected $F_{4:5}$ genetic ratios was determined via chi-squared analysis. The ratio of lines containing low to normal ADL concentrations demonstrated good fit with a 1:1 ratio ($\chi^2 = 0.53$, Table $\chi^2_{1df} = 3.84$). The observed genetic ratio did not fit any two gene ratios ($\alpha = 0.05$). The fact that the observed ratio is not significantly different than a 1:1 genetic ratio indicates that the low-lignin trait is controlled by a single gene. The frequency histogram of ADL concentrations for the RIL's demonstrates a bimodal distribution, as expected if the trait were controlled by a single gene (Figure 1).



Pearson correlational analysis indicated that groat percentage was not correlated with hull ADL concentration. Fat and protein concentration of the groat were also not correlated with ADL concentration. Hull ADL concentration was correlated with ADF concentration and hull colour (Table 1).

Table 1: Pearson correlational analysis of ADL, ADF, percent groat, groat oil (%), groat protein (%), ADF, L-value. All coefficients are based on an average of 3 replicates (n = 103).

	[ADL]	[ADF]	Groat Percentage	Groat Fat (%)	Groat Protein	Colour (L-value)
[ADL]	1.000					
[ADF]	0.761	1.000				
Groat percentage	-0.050	0.038	1.000			
Groat Fat (%)	-0.146	-0.171	0.043	1.000		
Groat Protein (%)	-0.123	-0.278	-0.064	0.355	1.000	
Colour (L-value)	0.573	0.300	0.124	0.025	0.038	1.000

The positive correlation of ADF and ADL was expected, as the ADL concentration is a component of the ADF value. The correlation between hull colour (L-value) and ADL concentration indicates that dark hull colour is associated with decreased ADL. This relationship is similar to that which has been found in the brown midrib mutants of corn, and sorghum (Halpin et al., 1998; Gupta, 1995).

References

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