Hulless Barley Mutants may Improve Alcohol Yields and Reduce Energy Use in Malt Whisky Distilling

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In hulless (naked) barley grain the *lemma* and *palea* are non-adherent. The hulless phenotype results from mutation in a gene on Chromosome 7H that regulates biosynthesis of the lipid that acts as an 'adhesive' in the wild-type. Hulless barley has generally been grown as a feed crop for non-ruminants, but there has been periodic interest in its possible use for malting, brewing and distilling.

Hulless Barley for Distilling?

Advantages

More rapid water uptake means that hulless barleys should malt more rapidly, with less energy requirement. As the husk contributes about 10% of the barley grain, but 0% of the starch, which is broken down to provide the sugars for fermentation, hulless barleys have a much higher alcohol yield potential. Additionally they produce less waste for disposal.

Disadvantages

Loss of the husk means grain is smaller, so higher screening losses are possible. The husk also protects the embryo from damage in grain handling, giving more even germination and modification. In addition, absence of demand, from the malting industry, has meant few, if any, hulless varieties, suitable for cultivation in the UK, have adequate quality.

Filtration Problems and Industry Research

Traditional distillery mash tuns use gravity to filter the wort and husk particles have been considered essential to form a filter bed, but recent research, within the whisky industry, has suggested that the extent of malt modification may be more important for rapid filtration. Industrial research does have some problems, however, in comparing hulled and hulless varieties, due to differences in genetic backgrounds. The alternative, i.e. using chemical de-husking to create a 'hulless' version of a malting variety, introduces an additional treatment effect, as it destroys any micro-organisms on the grain surface.

Materials and Methods

Population

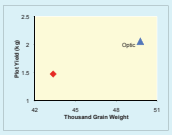
We made use of a mutant population initially developed in the hulless variety Penthouse, to induce variation in grain morphology. 38 lines plus Penthouse and the malting variety Optic were included in a trial of 2 replications grown at SCRI, Dundee in 2008, using the standard agronomy for malting barley, with fungicide application to control disease.

Malting and Malt Analyses

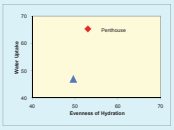
Grain was malted according to the regime employed, to compare Optic and Penthouse, by the Scotch Whisky Research Institute. This enabled our comparisons, between these two varieties to have commercial relevance, while the mutant lines permitted variation in quality parameters to be assessed within a common genetic background. In addition to the grain characters Thousand Grain Weight (TGW), Grain Length to Width ratio (L:W) and Nitrogen (N) Content, we measured weight of grain not retained by a 2.25mm sieve (screenings), extent and evenness of water uptake in steeping, malt extract and predicted alcohol yield. Associations between the characters were also determined.

Initial Findings

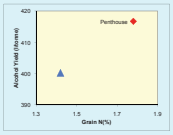
Comparison of Optic and Penthouse



Optic had larger grain and higher grain yield

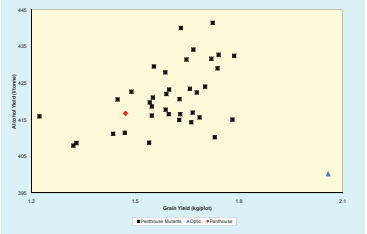


Penthouse showed more extensive hydration but not less even



Penthouse had higher Alcohol Yield, despite higher Grain N

Grain and Alcohol Yields of Penthouse Mutants



Correlation Matrix for Penthouse Mutants

	Alcohol Yield	Extract	Grain N%	TGW	Screenings <2.25mm	Grain L:W
Extract	0.725***					
Grain N%	-0.534***	-0.397*				
TGW	0.157	-0.169	-0.435**			
Screenings <2.25mm	-0.288	0.028	0.315*	-0.269		
Grain L:W	-0.359*	-0.325*	0.292	0.019	0.441**	
Water Uptake	-0.249	-0.211	0.464**	-0.037	0.125	0.105

* significant at the 5% level, ** significant at the 1% level, *significant at the 0.1% level

Mutant lines that exceeded Penthouse for both grain and alcohol yield were observed, but grain yields were all lower than Optic.

Alcohol yield and extract showed a strong negative association with grain nitrogen, as generally observed in covered grain.

Unlike covered grain, however, increased water uptake was not associated with improved malting quality, so further investigation is necessary.

Alcohol yield was associated with grain L:W, but not TGW, suggesting that grain shape may be more important than increased grain size *per se*.

Future Research

There is requirement for further malting and malt analyses, to investigate variation in both growing and malting environments.

There appears to be real opportunity for hulless barley, due to its environmental credentials, but there is a clear need to increase grain yield.

The optimum phenotype for hulless malting barley needs to be established, since the proportion of endosperm components will be increased and the ideal balance may differ from that in covered barley.

There are further opportunities to characterise the mutants or to search for mutations in genes known to influence quality. Those involved in synthesis of cell wall components could be a target.

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