Proceedings of the 10th Australian Barley Technical Symposium, 2001

Further development of the SWIFT filterability test

Chris Ford[1], Martin Barski[1], Sue Logue[1], Doug Stewart[2] and Evan Evans[1]

[1]Department of Plant Science, Adelaide University, Waite Campus PMB1, Glen Osmond, SA 5064
[2] Adelaide Malting Company, Cavan, SA 5094

Abstract

A small-scale syringe-based filtration test (SWIFT) that provides rapid, simple and reliable predictions of beer and wort filterability has been developed. Clarified wort and beer samples are filtered through a 13 mm 0.45 or 0.2-micron nylon filter using a 10 ml syringe to generate negative pressure. By comparing the weights of filtrates collected over a specified time period for different samples, a reliable indicator of filterability is readily obtained. Initial trials showed that wort filterability data generated by SWIFT are highly correlated with results obtained using industry-standard methods of determining filterability (Vmax; Diatomaceous Earth filtration). The results of our latest trials, using 20 Australian malts, show that SWIFT filterabilities measured from EBC hot water extracts and worts generated by a small-scale brewing protocol correlate well with SWIFT and Vmax filterability data of beer brewed from the malts. Thus, SWIFT provides a valuable tool for brewers and maltsters, permitting early detection of potential filterability problems in the finished beer. Further work indicates that good discrimination of malts is possible, suggesting that the test may provide a useful aid to barley breeders. We are testing the performance of SWIFT with advanced breeding line material as a preliminary to including the test in our routine evaluation of new lines.

Introduction

Filtration plays a critical part in the production of bright beer. Consumer perception of product quality is based predominantly on visual cues, and clarity is a major factor for beer acceptability. Some form of filtration is commonly used immediately prior to bottling or kegging. Breakdowns in filtration cellars due to blockages can be expensive and have consequences in downstream operations including packaging and dispatch. Tests to predict filterability can provide early indications of potential problems and are widely used to provide assurance of successful beer filtration prior to large-scale packaging of the product.

We previously developed a small-scale test that predicts beer filterability from measurements made on sweet wort [1,2]. The Small-scale Wort rapId Filtration Test

(SWIFT) uses negative pressure generated by a 10-ml syringe to draw clarified wort through a 0.45-micron filter, and has the advantages of being simple to perform, quick and cheap when compared to traditional methods of filterability determination. SWIFT was shown to correlate well with existing methods for assessing beer filtration efficiency, including membrane and diatomaceous earth-based protocols [2]. These early results suggested that SWIFT might provide an alternative to more involved tests of filterability commonly used in breweries and maltings.

Our recent work, presented here, has extended the original scope of SWIFT, examining the correlation between the filterability of hot-water extracts, worts and beers derived from a large number of Australian malts using SWIFT and Vmax measurements.

We have also examined the sensitivity of SWIFT with regard to the discrimination of malt samples, as an aid particularly to barley breeders in early multi-site evaluation of potential new malting varieties. It is hoped to increase the scope of SWIFT to include barley breeders, maltsters and brewers in the list of potential users.

Materials and Methods

The original SWIFT test was described in our earlier work [1]. Clarified extract, wort or degassed beer is drawn through a nylon (Polyamide) membrane filter (13 mm diameter, 0.45-micron pore-size), using negative pressure generated from a syringe with its plunger withdrawn to a fixed volume. A two-way tap beneath the filter unit is opened to start the filtration period, and closed after a pre-determined interval (usually 60 seconds). The use of a 10-place rack allows concurrent measurement of up to nine samples (three triplicate determinations) with a five-second gap between the start of each measurement.

In a significant modification to the published procedure, disposable syringe filters were tested as replacements for the refillable units used previously. The reliability of these filters was improved dramatically by pre-flushing with sterile-filtered water. This removed air-bubbles that otherwise blocked the passage of liquid during filtration, causing inaccuracies between replicate samples.

Hot water extracts were produced from 5 g malt samples using a method based on the Analytica EBC protocol. Boiled worts (diluted to 10^0 Plato following removal of cold break material) and beers were made using the Small Scale Brewing procedure described earlier [3]. Hot water extract analyses were performed according to protocols based on those described in the Analytica EBC. Vmax measurements were made using the method described in [3]. All SWIFT determinations were made in triplicate, and the results analysed using the statistical package Genstat.

Results and Discussion

A comprehensive survey of Australian malts confirms the durability of SWIFT

24 malts from barleys grown across Australia were analysed. Hot water extracts prepared from 5.00 g samples of grist (0.2 mm grind) were tested for SWIFT filterability and a range of quality parameters (viscosity, extract, soluble protein, wort and malt β-glucan, and Kolbach index). Boiled worts and the fermented beers produced from them were tested for filterability using SWIFT and Vmax (beers only). The results are presented in Table 1.

SWIFT filterability of hot water extracts (HWEs) and beer Vmax data were significantly correlated ($r=0.7$, $n=24$, $P<0.05$). SWIFT filterability data for HWEs and boiled worts had a statistically significant correlation of 0.61, while the correlation HWEs and beer SWIFT values was 0.63. Boiled wort and beer SWIFT data showed a correlation of 0.86, suggesting that boiling had a beneficial effect on the ability of SWIFT to predict beer filterability. As seen in earlier work [1], beer SWIFT correlated well with the Vmax test for filterability ($r=0.8$; $n=24$, $P<0.05$). This provides further evidence that SWIFT is a reliable measure of potential filterability. SWIFT filterability and viscosity of HWE were highly correlated ($r=-0.73$; $n=24$, $P<0.05$); there were no other significant malt parameters that correlated with SWIFT filterability.

In a separate series of trials, SWIFT filterabilities for HWEs were compared with those assayed using extracts boiled for 60 minutes prior to equilibration to 24°C. Correlations of SWIFT data between the two treatments ranged from 0.6 (n=16) to 0.85 (n=12, in both cases $P<0.05$), suggesting that changes in extract composition during the boil were reflected in altered filterability data. Further work is underway to determine the nature of these changes, but the removal of proteinaceous material by the hot and cold breaks is a likely candidate.

Table 1. Correlation data of malt filterability and malt quality data, 24 malts

	HWE SWIFT	**Wort SWIFT**	**Beer SWIFT**	**Beer VMAX**	**Extract**	**Viscosity**	**Soluble Protein**	**Wort β-Glucan**	**Malt β-Glucan**	**Kolbach Index**
HWE SWIFT	*									
WORT SWIFT	0.613*	*								
Beer SWIFT	0.631*	0.864*	*							
Beer VMAX	0.695*	0.768*	0.8*	*						
Extract	0.146	0.153	0.103	0.075	*					
Viscosity	-0.73*	-0.727*	-0.691*	-0.616*	-0.039	*				
Soluble Protein	0.319	0.38	0.346	0.457	-0.255	-0.327	*			
Wort β-	-0.301	-0.242	-0.348	-0.509	0.09	0.408*	-0.43	*		

Glucan										
Malt β-Glucan	0.25	0.151	0.073	0.157	-0.561	-0.162	0.391	-0.061	*	
Kolbach Index	0.372	0.229	0.275	0.3	0.235	-0.179	0.612*	-0.357	-0.486*	*

* $P<0.05$

SWIFT discrimination of closely specified malts

We were concerned that although SWIFT provides a good determinant of potential beer filterability from HWE or wort samples, the ability of the test to discriminate samples with similar specifications may be limited. For it to be of value in breeding programs, in which incremental improvements in malt quality (including filterability) are the normal outcome, the SWIFT test must be capable of robust and reliable detection of very small differences in filterability. As a preliminary evaluation of the sensitivity of SWIFT, eight malts representing Australian barleys grown for malting (n=5) or feed purposes (n=3) were used to prepare HWEs as described above. SWIFT determinations of filterability were made for each HWE (6 replicates); the trial was designed and analysed as a Randomised Complete Block Design. Malt specifications (density, wort β-glucan and viscosity) were determined as described above. Results are displayed in Figure 2 and Table 2

A statistically significant difference (Variance ratio = 39.48, n=48, $P<0.001$) was seen in the mean SWIFT filterability data for the 8 malts tested. A clear discrimination in mean SWIFT filterability occurred between the feed varieties and 3 of the malting varieties. SWIFT data for 2 malting varieties did not allow their discrimination from feed varieties. Wort viscosity was correlated with SWIFT value ($r= -0.71$, $P<0.05$); but wort β-glucan and density showed no significant correlation with SWIFT. Wort β-glucan levels explained 91% of the variation in viscosity between the 8 varieties.

These data suggested that the SWIFT test was indeed capable of discriminating malts that were otherwise closely specified. Additional trials are underway to develop the discriminative power of SWIFT still further, by comparing filterability data over varying time periods and filter sizes. We are also testing the filterability of over 40 barleys grown over seven sites in South Australia to provide a full evaluation of the SWIFT test in our barley breeding program.

Conclusion

The SWIFT test has been extensively evaluated and shown to be a reliable predictor of beer filterability. Further development of SWIFT is underway to improve the discrimination of similarly specified malts. We are currently examining SWIFT determinations of HWE filterability from barleys in advanced breeding trials at

several sites across South Australia; these results will be critical in determining the future of SWIFT as an aid to our breeding programs.

Acknowledgments

This work is supported by the Grains Research and Development Corporation of Australia. Philippa Tansing and Rebecca Fox of the Barley Quality Evaluation Laboratory, Department of Plant Science, Adelaide University, are gratefully acknowledged for their assistance with preparation and analysis of hot water extracts.

References

1. Stewart, D., Freeman, G. and Evans, E. (2000). Development and assessment of a small-scale wort filtration test for the prediction of beer filtration efficiency. *J. Inst. Brew.* **106**, 361-366.
2. Stewart, D., Freeman, G. and Evans, E. (2000). Better prediction of the Beer Filtration Efficiency of malt. Proceedings 26th Convention of the Institute of Brewing-Asia Pacific Section, Singapore. 47-51.
3. Stewart, D.C., Hawthorne, D. and Evans, D.E. (1998). Cold Sterile Filtration: A Small Scale Filtration Test and Investigation of Membrane Plugging. *J. Inst. Brew.* **104**, 321-326.