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THE TECHNICAL JOURNAL OF NEWPORT SCIENTIFIC®
FEBRUARY 2007
ISSN 1449-1311

The use of the RVA™ to predict Falling Number: the Canadian experience

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OBJECTIVE

To determine the feasibility of using the RVA–StarchMaster to predict Hagberg Falling Number (FN) in Canada Western Red Spring (CWRS) and Canada Western Amber Durum (CWAD) wheat on a large-scale, national basis.

INTRODUCTION

The Canadian grading system utilises a visual assessment of grain to determine sprout damage. This is a time-intensive procedure, ~20 min. per sample, and is extremely cumbersome to the rapid movement of grain to port positions. A single kernel of severely sprouted wheat can range from 100 to 50,000 mg maltose x 10-3/g/min. units of alpha amylase activity. Such a range in activity cannot be accurately determined by visual means, making the Hagberg FN test an ideal system for wheat commerce. However, the use of the Hagberg test is also time-intensive, requiring over 6 min. (360 s) for a sound sample to be analysed. The Rapid Visco Analyser (RVA) offers the ability to carry out the same assessment in a maximum of 3 min. To date, the use of the RVA to analyse wheat samples has been confined to small studies using less than 1000 samples.

MATERIALS AND METHODS

Equipment

A preliminary study indicated that the RVA–StarchMaster offered the desirable combination of ruggedness and multi-calibration features necessary for the analysis of multiple classes of Canadian wheat.

Wheat Samples

Samples were secured from individual railcar shipments of CWRS to eastern and western Canadian port positions in 2000, 2001 and 2002. Additional samples of CWRS and CWAD from the 2002 harvest were acquired from primary elevators through the active participation of members of the Canadian grain industry in the study.

Sample analysis

Individual wheat samples were thoroughly mixed prior to being passed through a Borne divider to secure representative samples (minimum 300 g each). The 300 g sample was then ground on a Model 3100 grinder (Perten, Sweden) and thoroughly mixed. The grinders (3) used in this study were thoroughly cleaned with a vacuum and brush between each sample. Moisture content of the ground wheat meal was determined using a Dickey-John NIR calibrated for individual classes of Canadian wheat.

The ground meal sample was again thoroughly mixed prior to 7.0 g moisture corrected material being weighted out for the Hagberg FN test (AACC Method #56-81B). The Hagberg FN test was carried out using Perten FN machines, models 1600, 1700 and 1800 which require duplicate tube analysis. The Hagberg FN values used throughout this study represent the average of the two tubes analysis.

A wheat meal sample (4.0 g corrected for moisture) was also analysed using the RVA–StarchMaster as per AACC Method #22-08.

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RESULTS

Reproducibility

Method reproducibility studies were carried out on two CWRS wheat samples (high and low FN) by the RVA–StarchMaster. A single grind (Model 3100 grinder) each day allowed 4 separate RVA analyses each day. This was carried our over 5 days and the results are seen in Table 1. The results indicate that the RVA–StarchMaster yields highly reproducible results over multiple days.

Table 1
Reproducibility of RVA analysis over a 5-day period.

FRESH GRIND	LOW FN SAMPLE FINAL VISCOSITY	STD. DEV.	COEF. OF VAR.	HIGH FN SAMPLE VISCOSITY	STD. DEV	COEF. OF VAR.
	cP		%	cP		%
Day 1	763	24.6	3.2	1415	8.8	0.6
Day 2	738	9.6	1.3	1416	24.9	1.8
Day 3	756	15.6	2.1	1355	9.0	0.7
Day 4	770	10.4	1.4	1380	4.8	0.3
Day 5	815	55.3	6.7	1403	17.7	1.3
Overall (20)	769	37.3	4.9	1394	27.3	2.0

Analysis of three different machines using three samples with significantly different FNs also yielded excellent machine to machine reproducibility. (Table 2)

SAMPLE	MACHINE	FINAL VISCOSITY	STD. DEV.	COEF. OF VAR.
		cP	cP	%
Sample 1	A	738.7	10.1	1.4
	B	748.0	6.2	0.8
	C	755.0	13.9	1.8
Sample 2	A	1161.0	5.0	0.4
	B	1190.7	6.0	0.5
	C	1182.3	9.0	0.8
Sample 3	A	1498.7	18.9	1.3
	B	1518.0	14.1	0.9
	C	1532.0	20.2	1.3

Table 2
Machine reproducibility (reps = 3).

Preliminary investigation using 20900 and 2001 CWRS wheat samples indicated that the calibration formulas provided by Newport Scientific were based on either Australian or American wheat samples and were inappropriate for predicting FN in Canadian wheat.

An initial analysis of over 1000 samples of 2000 and 2001 CWRS wheat samples resulted in a predictive polynomial with $r^2 = 0.96$ with a standard error of prediction of 12.9 s. All components in the polynomial were required as they displayed $p <= 0.0001$.

The calibration derived from the 2000 and 2001 samples were then utilised to predict the FN value of CWRS samples grown in 2002 throughout western Canada. The results confirmed the excellent predictive nature of the calibration. It achieved an r value of 0.89.

Comparison of identically divided CWRS samples (N=382) resulting from the 2002 harvest year, analysed in both a participating grain company's quality control facility with those analysed at the Grain Research Laboratory (GRL) demonstrated excellent agreement between RVA, estimated FN and the actual Hagberg FN value at both laboratories using a calibration (CWRS-v1.0) derived upon 2000 and 2001 crop material. (Industry $r^2 = 0.85$, GRL $r^2 = 0.92$)

Analysis of the four participating companies', RVA estimated CWRS 2002 crop FN value versus the actual Hagberg FN value can be seen in Table 3.

Although a good predictive capability was observed, improved discrimination using the RVA–StarchMaster was desired. Continued analysis of the 2002 CWRS crop alone generated a polynomial calibration between CWRS and RVA final viscosity with a r^2 = 0.94 and a SEP = 13.0 s.

CWRS data from the 2000, 2001 and the 2002 crop years were combined into a single polynomial calibration (CWRS-v2.0). The combined data yielded a r^2 = 0.93 and a SEP = 14.0 s after correction for outliers (N = 4486).

DIFFERENCE	INDUSTRY PARTNERS		GRL	
s	%	Cum. %	%	Cum. %
0-15	45.5	45.5	48.8	48.8
16-30	26.6	72.1	38.0	86.0
31-45	14.3	86.4	9.7	95.7
46-60	6.6	93.0	2.5	98.2
>60	7.0	100	1.8	100

Table 3
Analysis of the preliminary CWRS RVS predictive model (v1.0) for Hagberg FN values.

DIFFERENCE	INDUSTRY PARTNERS		GRL	
s	%	Cum. %	%	Cum. %
0-24	60.2	60.2	79.5	79.5
25-49	28.4	88.6	14.9	94.4
50-74	7.7	96.3	2.7	97.1
>75	3.7	100	3.0	100

Table 4
Comparison of the 2002 CWAD calibration to predict Hagberg FN values (N = 916).

During the 2002 crop year, participating companies supplied CWAD railcar shipment samples for the development of an RVA–StarchMaster calibration. Preliminary investigation quickly revealed that the CWRS calibration was not appropriate for Hagberg FN prediction in CWAD wheat.

Over 1700 samples of CWAD were analysed. A polynomial calibration relating RVA viscosity to FN (CWAD-v1.0) has been developed with r^2 = 0.87 and the SEP = 25.5 s.

A direct comparison between the GRL and grain company partners' RVA–StarchMaster predicted FN and the Hagberg FN value (N = 916). (Industry r^2 = 0.72, GRL r^2 = 0.83)

Analysis of identical samples analysed by the companies and the GRL can be seen in Table 4.

The reason for the higher than desirable SEP in CWAD has been tentatively identified. The issue lies in the hardness of the CWAD as compared to common wheats. Studies carried out within the GRL have found that there is a considerable difference in the particle size distribution of CWAD versus common wheat when milled on the Model 3100 grinder. The bulk of the CWAD material is significantly larger than that of common wheat. This causes uneven hydration of the particles and their corresponding swelling. As the RVA test requires only 3 min. to complete, uneven hydration is introducing greater errors in FN prediction.

CONCLUSIONS

Under GRL laboratory conditions the RVA–StarchMaster appears to offer a fast and efficient means to predict Hagberg FN values in Canadian CWRS and CWAD wheat. Further research will be required to ensure that this method is transferable from the laboratory to the operational environment of a primary or terminal grain elevator.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the commitment and financial contributions to this project by Agricore United Ltd, Con Agra Grain Ltd, the Saskatchewan Wheat Pool and Cargill Ltd. The financial contributions of the Canadian Wheat Board and AQT Inc. are appreciated.

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American Association of Cereal Chemists. 2000. Approved Methods of the AACC, 10th ed., Approved Method 56-81B and 22-08. The Association: St. Paul, MN.

Report on gelatinisation properties of different cereals and pseudocereals used as adjuncts in the brewing process

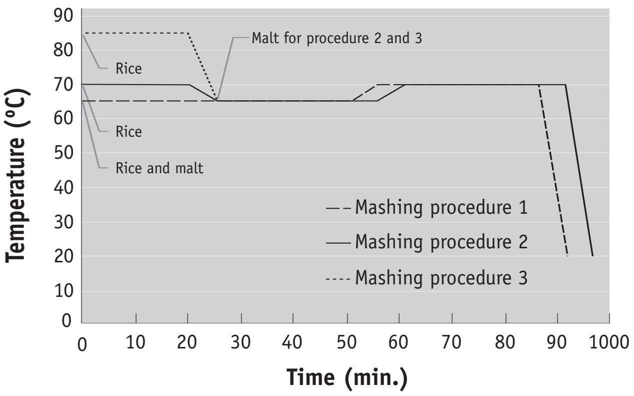
Worldwide, unmalted maize, rice, and sorghum are used as malt surrogates for wort and beer production as an extract source. Adjuncts are used for economic reasons and to make a light, stable beer.

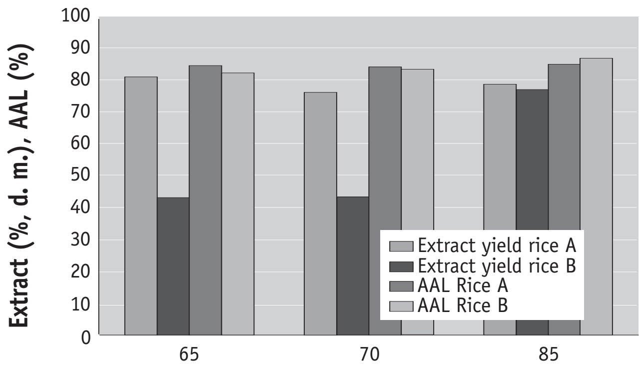
The adjunct has to be cooked before amylolysis and a low gelatinisation temperature of the adjunct is beneficial. An RVA-4 using ICC standard No. 162 with the STD 1 profile was used to determine the gelatinisation temperatures of two samples of rice. Rice with a gelatinisation temperature of 67°C was associated with higher extract yield than rice with gelatinisation temperature of 81°C when used with micro-scale mashing methods that used mashing-in temperatures of 65°C and 70°C. When the mashing-in temperature was increased to 85°C the temperature was high enough for the rice that gelatinised at 81°C to gelatinise and produce a higher extract yield.

Mashing-in temperatures far below the gelatinisation temperatures lead to poor extract yields. On the other hand, knowing about the gelatinisation temperature has economic advantage since lowering the temperature saves energy and raising it avoids loss of extract. Thus, determination of the gelatinisation temperature should be a routine test for brewing adjuncts.

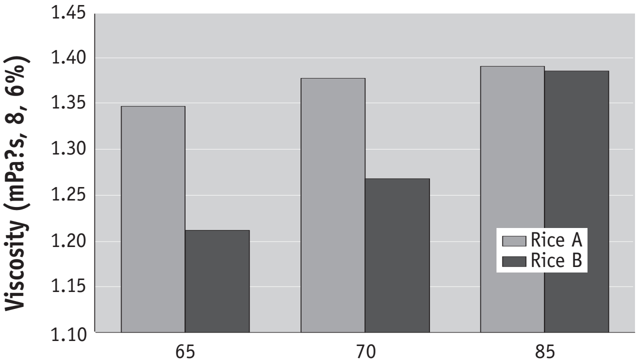
Reference: Keßler, M., Zarnkow, M., Kreisz, S. and Back, W., "Gelatinisation Properties of Different Cereals and Pseudocereals", *Monatsschrift für Brauwissenschaft*, September/October 2005, pp. 75–81.

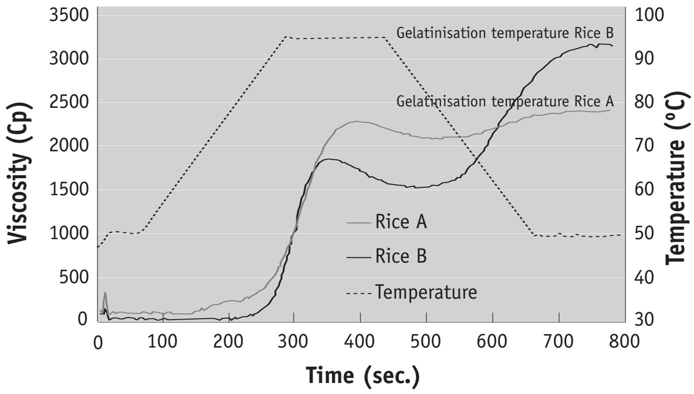
This method of detecting the gelatinisation temperature with the RVA has been published in *Mitteleuropäische Brautechnische Analysenkommission (MEBAK) II* Chapter 2.7 Verkleisterungstemperatur.





Above: Figure 1 *Mashing Profile* **Figure 2** *Extract yield and AAL.* **Below: Figure 3** *Changes in viscosity* **Figure 4** *RVA curves of rice A and B.*





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