High Speed Dough Tests and Flour Blend Modeling on doughLAB

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Introduction

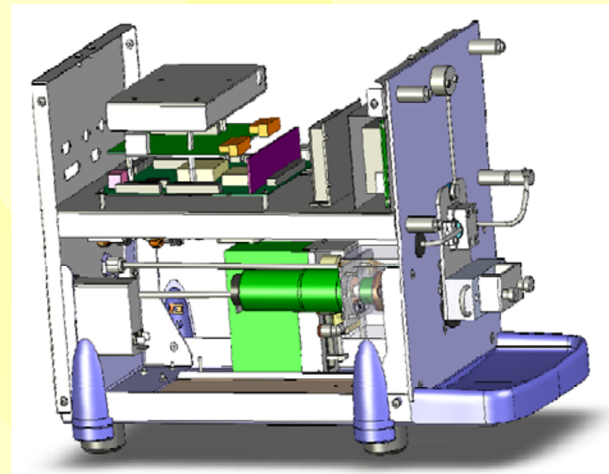
- ➔ **doughLAB is a lab/factory scale z-arm dough mixer.**
- ➔ **micro-doughLAB is a 4g z-arm dough mixer.**
- ➔ **Both use the same DLW software for instrument control, data acquisition and data analysis.**
- ➔ **Both are capable of accelerated tests at high energy input to develop samples that are difficult to develop, to incorporate ingredients such as fat, to reduce test time and to give a better indication of dough stability.**
- ➔ **Both are capable of modeling flour blends to predict their performance without having to run extra tests. Blending different flour varieties and mill streams enables the miller to reduce costs and maximize profits while producing different flour products for specific customers and specific uses.**

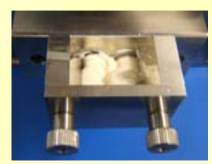
doughLAB

- ➔ 300g/50g (lab/factory scale) z- arm mixing to determine flour processing quality.
- ➔ Same results as Farinograph performing conventional test. (63 rpm, 30°C).
- ➔ High energy mixing to emulate commercial dough mixers.
- ➔ Variable speed mixing to research dough response to stress.
- ➔ Stepped speed mixing to incorporate ingredients (fat).
- ➔ Ramped temperature mixing to cook dough.
- ➔ DLW software for flour blending and curve analysis.

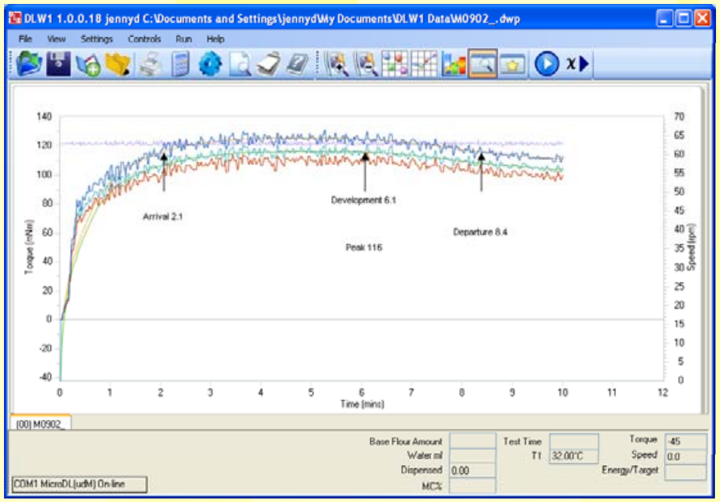
micro-doughLAB

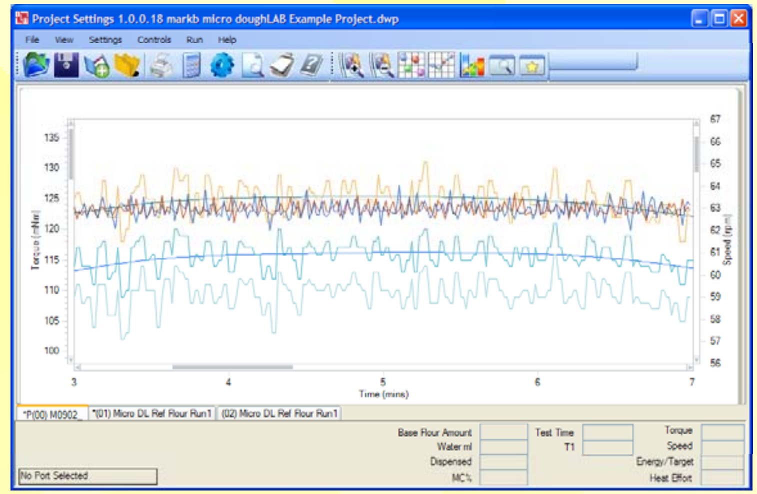
- ➔ 4g (research/breeder scale) mixing bowl with sigma (“Z”) blades, removable.
- ➔ Correlates with large scale methods.
- ➔ Sprung bowl with LVDT sensor for torque measurement.
- ➔ Mixer Speed Control 0 – 200 rpm.
- ➔ Integrated & automated (0 - 5 mL) water dispenser.
- ➔ External temperature control.
- ➔ Same high energy, variable speed and stepped speed mixing. Same ramped temperature mixing. Same DLW software.

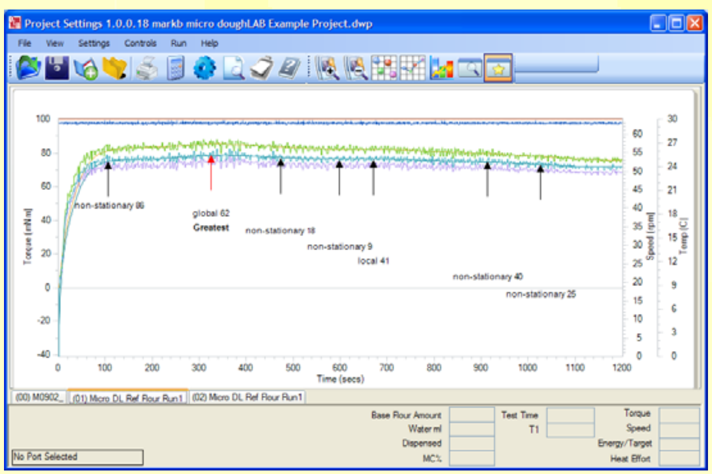


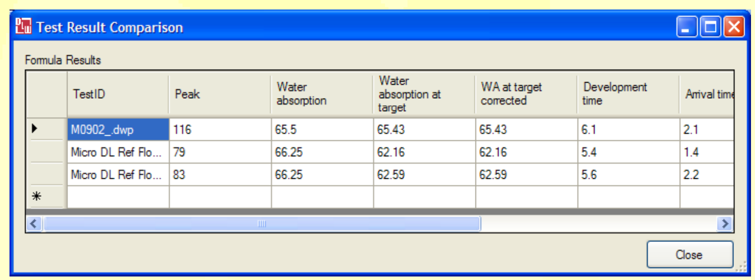


DLW Software Data analysis









TestID	Peak	Water absorption	Water absorption at target	WA at target corrected	Development time	Arrival time
M0902_.dwp	116	65.5	65.43	65.43	6.1	2.1
Micro DL Ref Flo...	79	66.25	62.16	62.16	5.4	1.4
Micro DL Ref Flo...	83	66.25	62.59	62.59	5.6	2.2

Aims - Durum Semolina

- ➔ **Assess the usefulness of accelerated tests for difficult to develop samples.**
- ➔ **Assess the capability and repeatability of the doughLAB (50g) in performing accelerated tests.**

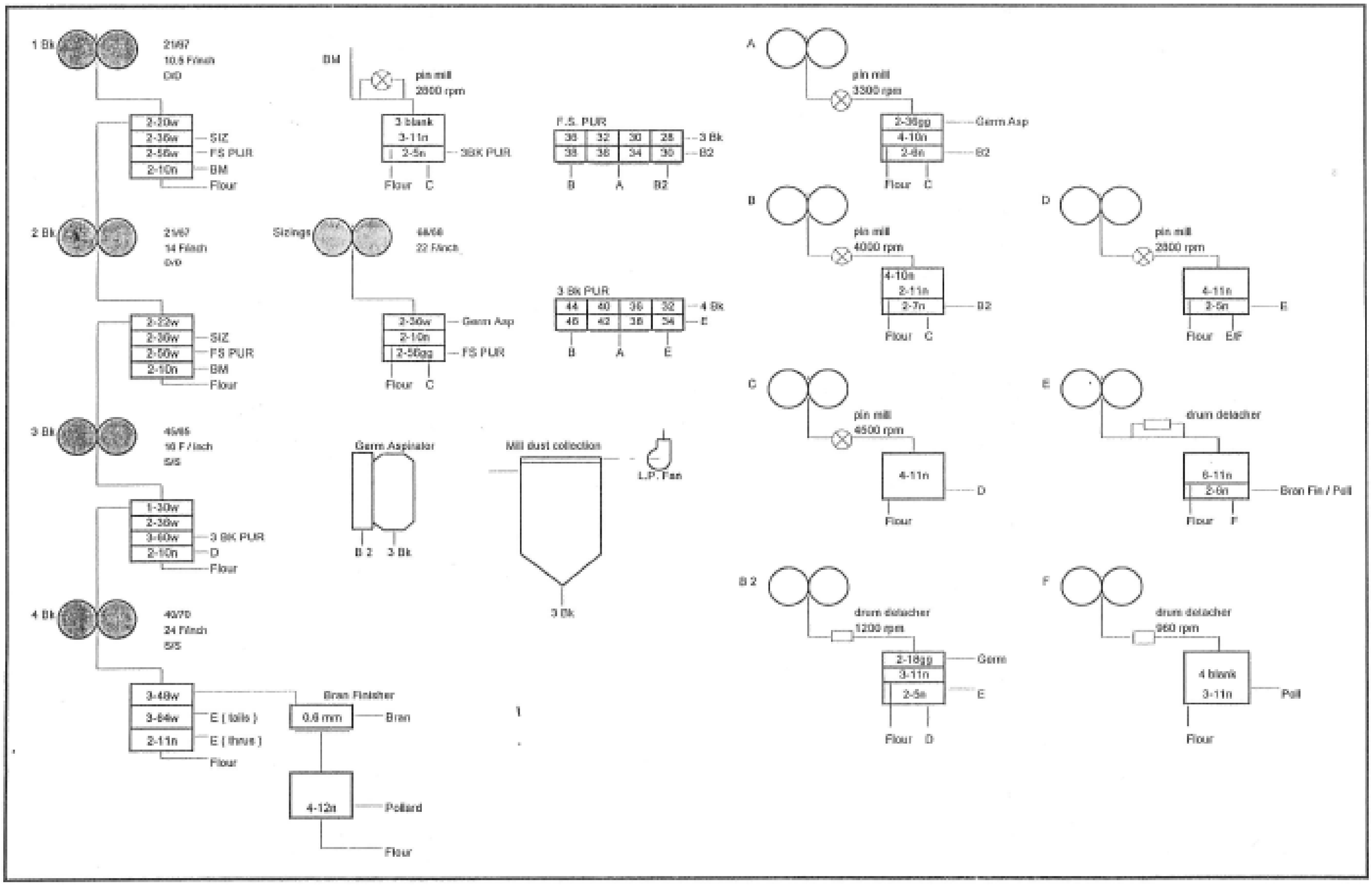
Aims - Flour Blending

- **Assess the capability and repeatability of the micro-doughLAB (4g) in modeling and predicting the characteristics of flour blends.**
- **Straight run flour and nominal noodle flour blends.**
- **Standard speed (63 rpm), standard temperature (30°C).**

Materials and Methods – (Semolina)

- **Twenty semolina samples (Tamworth, Australia).**
- **doughLAB, 50g bowl.**
- **Standard speed (63 rpm) and accelerated speeds (120 and 180 rpm).**
- **Repeatability was evaluated by one-way ANOVA.**

Materials and Methods (Flour)



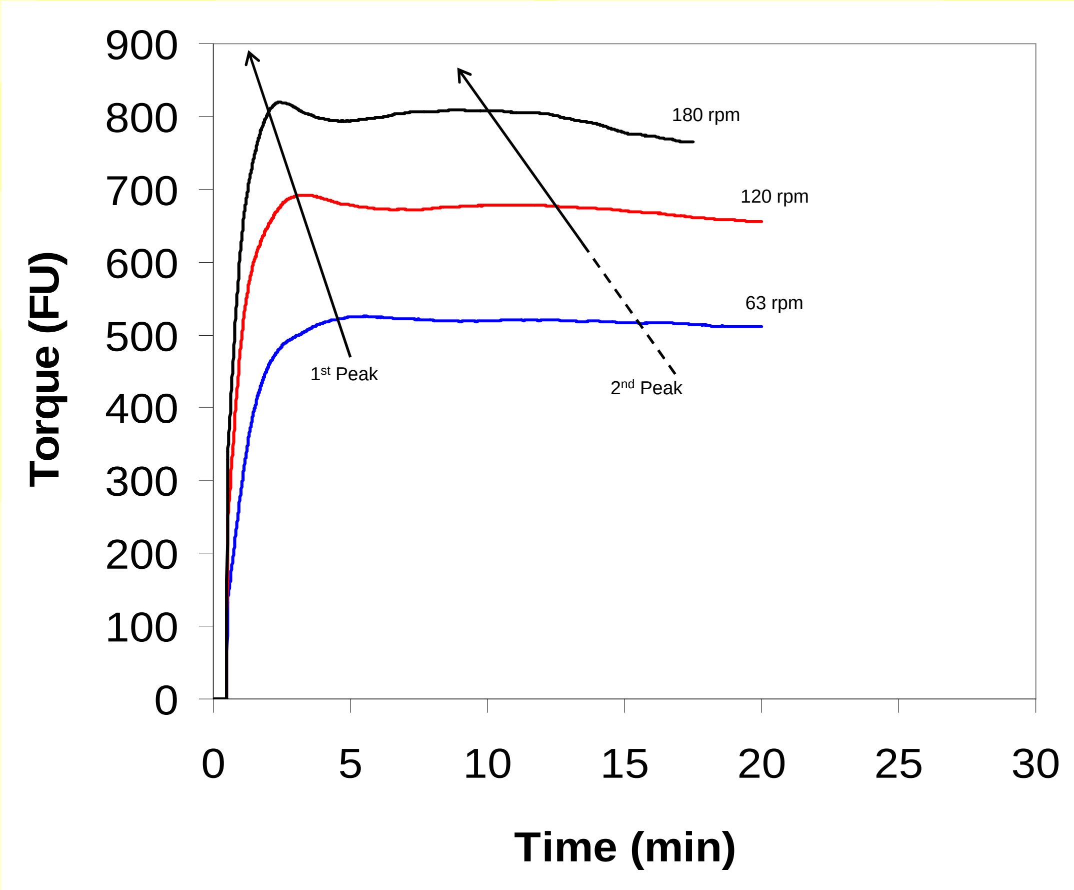
Materials and Methods (Flour – cont.)

- All samples Queensland, Australia, Prime Hard wheat.
- Typically for bread grist or to improve a low protein grist.
- 1 BK, 2 BK, 3 BK, 4 BK, A, B, C, B2, D, E, BF+F, SIZ, BM
- Blends: Straight run flour (bread) and Nominal noodle flour.

1 BK	*8.206g*
2 BK	*7.107g*
3 BK	*5.232g*
4 BK	*2.581g*
A	*17.707g*
B	*4.133g*
C	*13.180g*
D	*11.428g*
E	*7.366g*
BF&F	*4.715g*
SIZ	*3.615g*
B2	*9.500g*
BM	*5.232g*

1 BK	*13.867g*
2 BK	*12.009g*
A	*29.920g*
B	*6.983g*
C	*22.271g*
SIZ	*6.109g*
BM	*8.841g*

Results (Semolina)



Dough mixing curve of semolina at 63, 120, and 180 rpm.

Results (Semolina - cont.)

- ➔ **DDT and stability values were more repeatable at 120 rpm (smaller root mean squares (RMS) and lower coefficients of variation (CV)) than at 63 rpm.**
- ➔ **Testing at higher speeds will therefore produce more rapid and accurate results, thus increasing the efficiency of the mill/bakery/laboratory.**

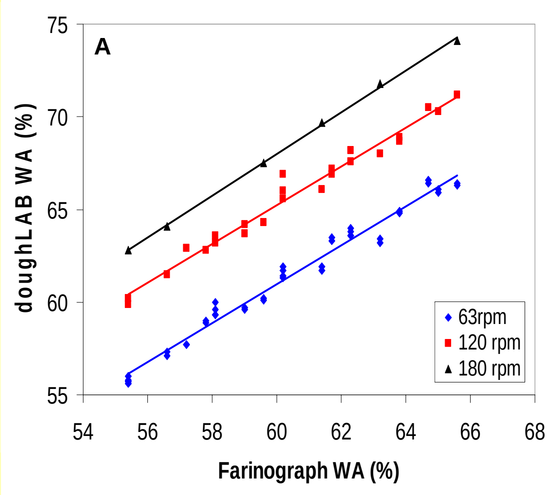
Parameter	*63 rpm*			*120 rpm*		
	Mean	*RMS*	*CV%*	*Mean*	*RMS*	*CV%*
Peak 1 (FU)	*542.2*	*6.34*	*1.2*	*713.9*	*10.35*	*1.5*
Peak 2 (FU)	*-*	*-*	*-*	*693.9*	*-*	*-*
WA 1 (%)	*61.4*	*0.14*	*0.2*	*65.8*	*0.26*	*0.4*
WA 2 (%)	*-*	*-*	*-*	*64.7*	*-*	*-*
DDT 1 (min)	*4.3*	*0.18*	*4.3*	*2.5*	*0.03*	*1.2*
DDT 2 (min)	*-*	*-*	*-*	*14.4*	*-*	*-*
Stability 1 (FU)	*4.8*	*0.37*	*7.6*	*4.7*	*0.2*	*4.3*

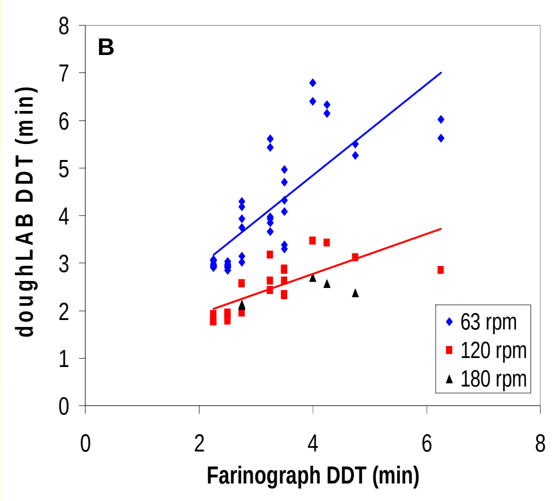
Results (Semolina cont.)

➔ **Parallel lines of WA calculation show that WA for the conventional test can be estimated from high speed tests simply by applying a suitable offset to the test value.**

Regression equations for WA and DDT for Farinograph and doughLAB tests on semolina samples.

Speed	Regression	R^2	RMS
63 rpm	dL WA = 1.049 Farino WA – 2.002	0.977	0.51
63 rpm	dL DDT 1 = 0.958 Farino DDT + 1.009	0.608	0.78
120 rpm	dL WA = 1.047 Farino WA + 2.416	0.977	0.49
120 rpm	dL DDT 1 = 0.421 Farino DDT + 1.083	0.523	0.39
180 rpm	dL WA = 1.126 Farino WA + 0.422	0.999	0.16





Comparison of WA (A) and DDT (B) between Farinograph and doughLAB for twenty semolina samples, at 63, 120 and 180 rpm.

Results (Semolina cont.)

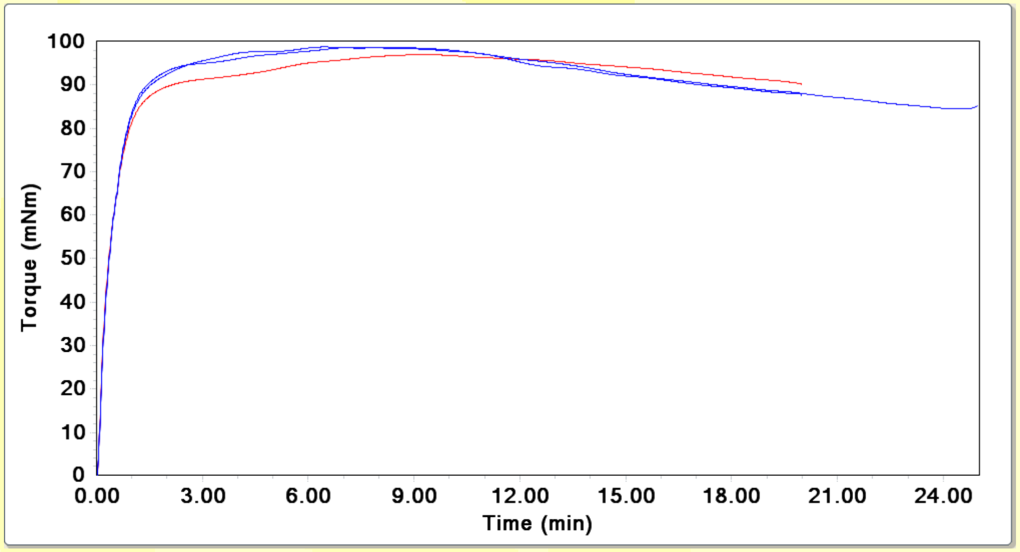
- ➔ **Results were generally more repeatable at higher speeds.**
- ➔ **Tests at higher speeds could be used to reduce test time and give a better indication of dough stability.**
- ➔ **Increasing mixing speed resulted in better peak resolution and earlier DDT. At higher speeds, a second peak was evident in several samples which suggests that testing semolina or any difficult-to-develop samples at standard speed would bias results to detect only the first peak. The second peak was taken to be the true mixing peak (Shuey, 1997).**
- ➔ **The slopes of the regression equations for WA at all three mixing speeds were essentially parallel suggesting that there was a simple offset in WA at higher speeds, which would allow the conventional WA values to be estimated using high-speed tests without any loss of discrimination between samples.**
- ➔ **The regression equation for DDT at 120 rpm demonstrates the advantage of an accelerated test for difficult-to-develop samples, where the DDT is approximately half that at 63 rpm.**

Results (Flour)

Sample	*WA*	*DDT*	*Stability*	*Softening*	*MTI*
1st Bk	*56.4*	*10.45*	*12.00*	*13*	*7*
2nd Bk	*58.8*	*12.80*	*15.15*	*N/A*	*5*
3rd Bk	*60.6*	*13.25*	*18.75*	*5*	*1*
4th Bk	*63.9*	*7.45*	*21.85*	*5*	*3*
A	*66.3*	*2.25*	*20.00*	*3*	*2*
B	*64.7*	*11.90*	*11.15*	*12*	*3*
C	*60.4*	*12.00*	*14.10*	*6*	*4*
D	*66.4*	*5.35*	*13.30*	*8*	*3*
E	*65.9*	*5.40*	*10.55*	*12*	*6*
BF&F	*76.6*	*6.05*	*4.00*	*14*	*10*
SIZ	*58.4*	*8.90*	*14.95*	*8*	*5*
B2	*59.5*	*7.50*	*13.25*	*9*	*6*
BM	*57.1*	*7.65*	*10.90*	*10*	*8*
Noodle Blend	*60.8*	*10.90*	*16.80*	*10*	*5*
Straight Blend	*62.2*	*6.45*	*13.20*	*10*	*3*

Results (Flour) – Straight Run Blend

- **DLW software closely predicted mixing characteristics of flour blends**

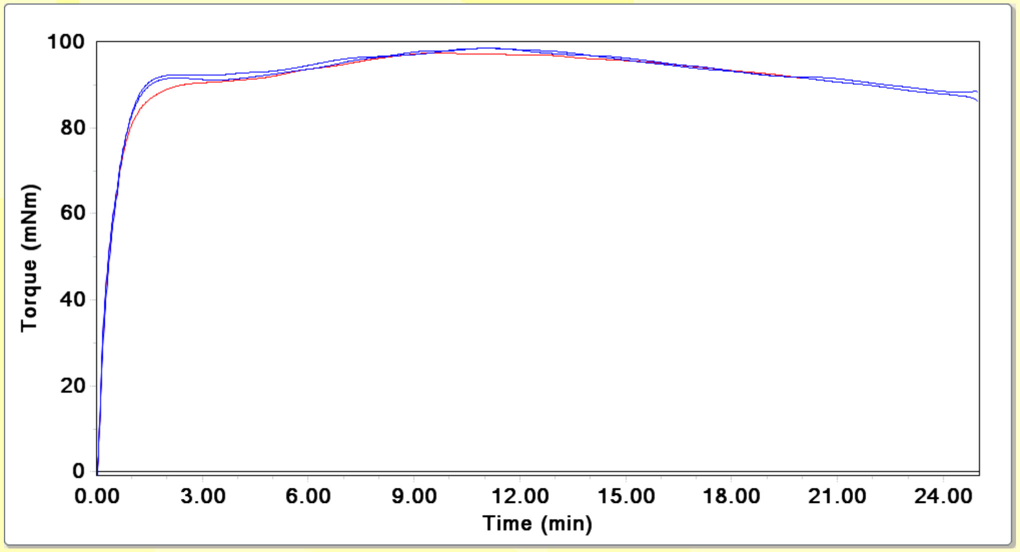


Actual (blue) versus Virtual (red)

	WA (%)	*DDT (min)*	*Stab (min)*	*Softening (mNm)*	*MTI (mNm)*
Virtual	*62.4*	*7.90*	*17.40*	*6*	*2*
Actual	*62.2*	*6.45*	*13.20*	*10*	*3*

Results (Flour) – Noodle Blend

➔ **micro-doughLAB gave good repeatability for WA and DDT (low CVs and small RMS)**



Actual (blue) versus Virtual (red)

	WA (%)	DDT (min)	Stab (min)	Softening (mNm)	MTI (mNm)
Virtual	61.0	12.10	17.90	N/A	4
Actual	60.8	10.90	16.80	10	5

Results (Flour cont.)

Mixing parameter	*Mean*	*RMS*	*CV (%)*
WA (%)	*62.51*	*0.15*	*0.25*
DDT (min)	*8.55*	*0.82*	*9.53*
Stability (min)	*14.00*	*2.02*	*14.41*
Softening (mNm)	*8.85*	*1.59*	*18.00*
MTI (mNm)	*4.50*	*1.20*	*26.60*

Conclusions

- ➔ **Increasing mixing speed resulted in better peak resolution and earlier DDT on the doughLAB.**
- ➔ **Conventional WA results can be predicted from high speed tests on the doughLAB.**
- ➔ **DLW very closely predicted the WA of the blends.**
- ➔ **DLW closely predicted DDT and stability of the blends.**
- ➔ **doughLAB and micro-doughLAB rapid tests can help the miller save time determining the processing characteristics of flour.**
- ➔ **doughLAB and micro-doughLAB blend modeling function can help the miller reduce costs and maximize profits while producing different flour products for specific customers and specific uses.**

Acknowledgements

- ➔ **For the micro-doughLAB and doughLAB work, Jennifer Dang and Alison Curtis, Newport Scientific R & D Laboratory, Sydney, Australia.**
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