

GLUTOPEAK: A BREEDING TOOL FOR SCREENING DOUGH PROPERTIES OF DURUM WHEAT

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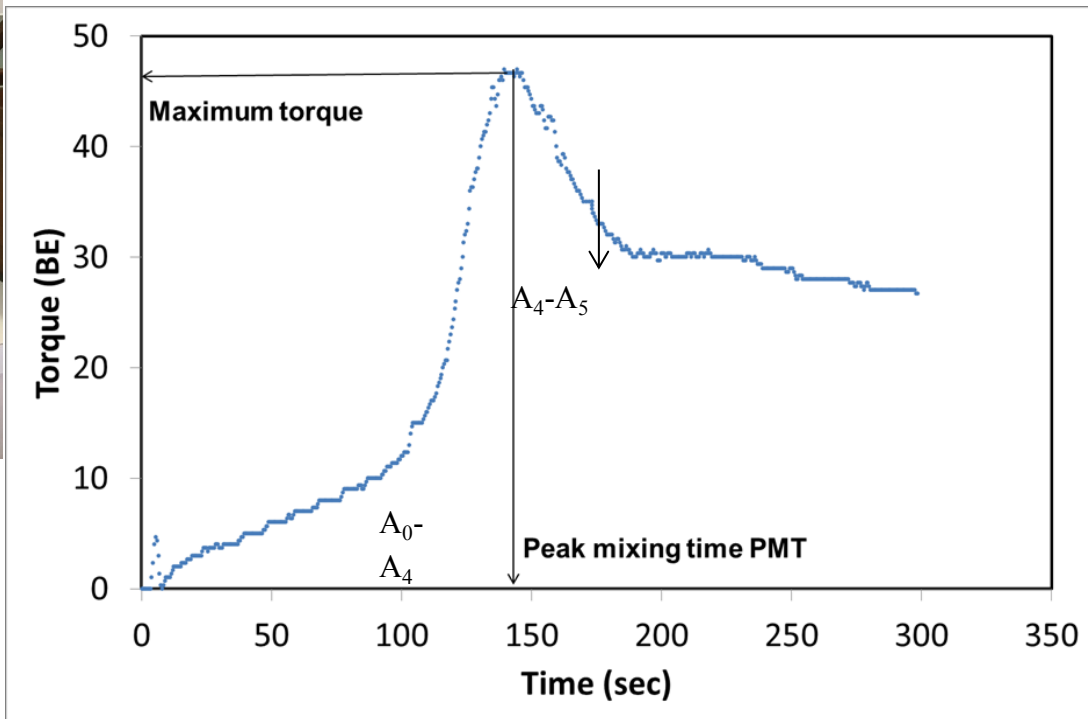
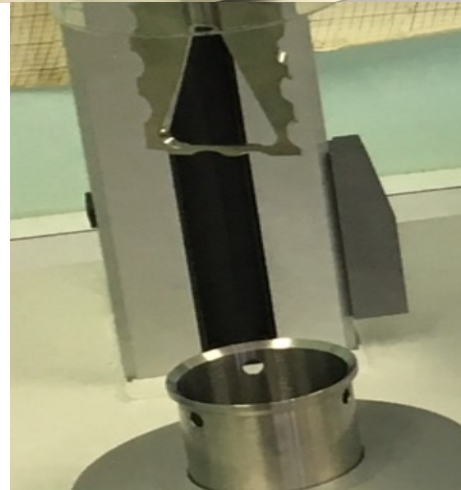
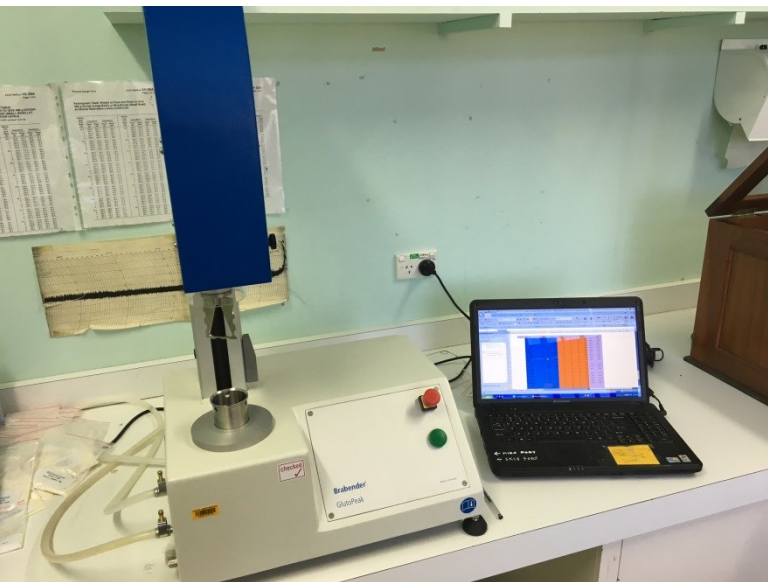
Background

- Durum wheat gluten strength influences pasta processing
- When semolina is hydrated and kneaded, a protein matrix is formed and its “strength” is a reflection of the genotype and GxE
- In breeding durum, weak-medium strength ($GI < 60$; poor mixograms) genotypes are typically culled
- To make rapid gains in breeding for gluten strength and pasta quality, testing in early generations is desirable
 - small sample size, rapid, inexpensive, easy procedure
- There are several rheological methods to assess dough

Rheological Approaches Commonly used in a Durum Breeding Program for Semolina Characterization^a

Test	Principle	Time to complete one analysis (min)	Minimum sample required (g)	Comments
Gluten index	Measures the amount of wet gluten remaining on a specially constructed sieve after centrifugation under standardized conditions	~12	10	Very weak or samples with poor gluten development fail to form a gluten ball giving no results
Mixograph	Measures dough mixing characteristics using a pin mixer	~12	10	Affected by variation in water absorption; poor at discriminating moderately strong from strong genotypes
SDSS	Measures the amount of sediment after mixing flour in an SDS-lactic acid solution for a fixed time	~25-30	1	Poor discrimination of moderately from strong gluten types
Glutograph	Measures the extensibility and elasticity of washed wet gluten, isolated from flour	~15	10	Highly influenced by the analyst, poor reproducibility
Farinograph ^b	Measures flour water absorption and dough mixing characteristics using a Z-arm mixer	~25-30	10-50	Slow with poor discrimination of moderately strong from strong types
Alveograph	Measures resistance to three-dimensional extension of a thin sheet of dough, prepared at a constant hydration level (43.3%)	~45-50	250	Requires too much sample, slow, influenced by operator
GlutoPeak	Measures the aggregation behaviour of gluten in flour samples	~8-10	8-10	Good potential

Glutopeak-what is it?



Typical semolina curve

- Glutopeak publications ~8-10
- Other rapid small scale tests (mg sample)
 - Glutenin polymeric distribution (UPP%)-SE-HPLC
 - Insoluble glutenin content (IP)-Turbidity assay
 - Swelling index of glutenin (SIG)

Aims:

- Compare GlutoPeak wholemeal and semolina aggregation properties with other dough methods mixograph, SDSS, gluten index
- Correlation between GlutoPeak and the other rapid tests
- Evaluate GlutoPeak to predict strength on breeder's samples

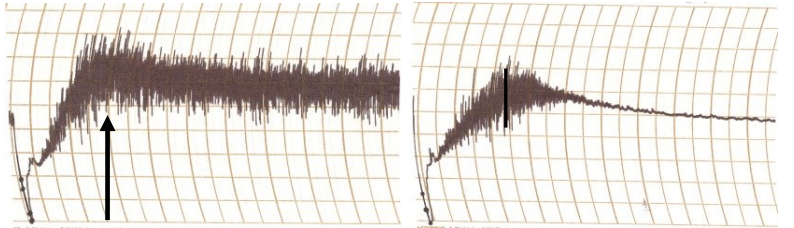
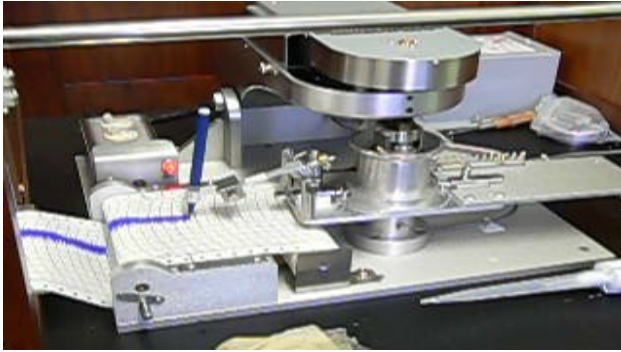
A close-up photograph of a stainless steel bowl filled with whole durum wheat grains. The grains are light brown and have a characteristic oval shape with a pointed end. The bowl is positioned at an angle, and the background is a solid light blue color.

Methods

- 145 durum grain samples milled by FN mill into wholemeal and by Buhler mill into semolina
- Dough tests-Glutopeak (9g/10g water, $\sim 30^{\circ}\text{C}$, 5min, 2700rpm), mixograph, gluten index, SDSS

Glutomatic

Mixograph

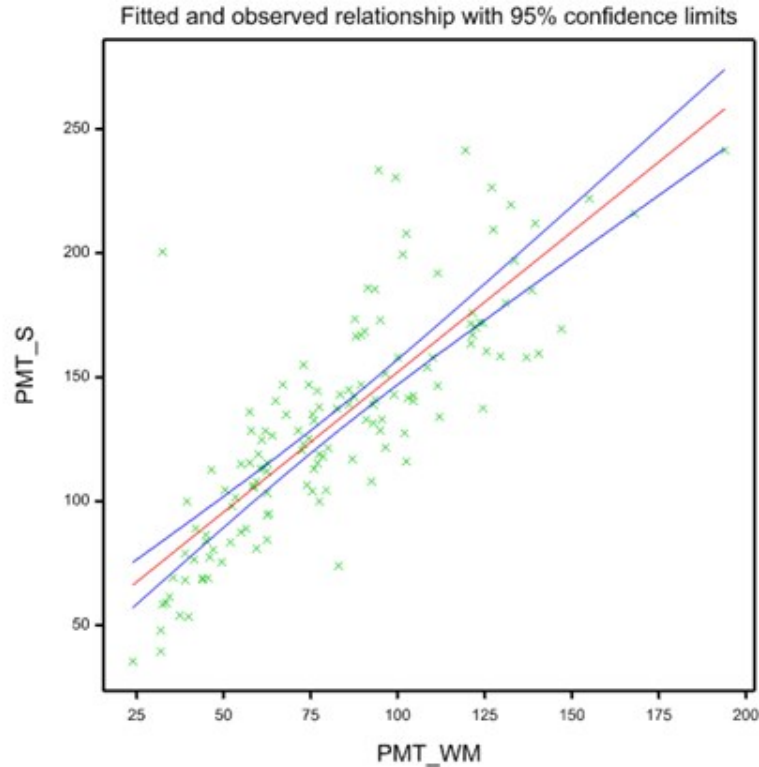


Mixograph Peak Time

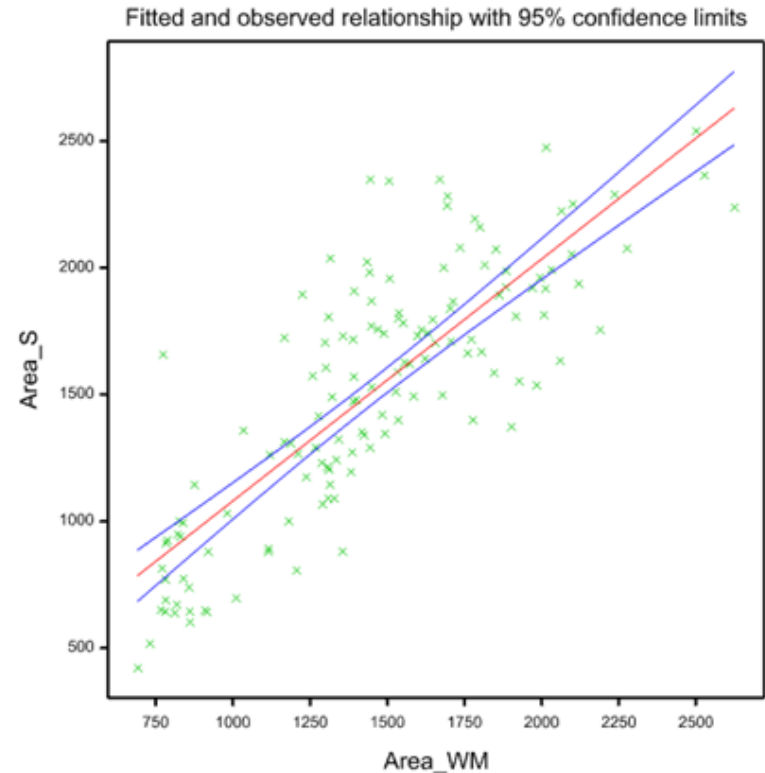


Resistance
Breakdown

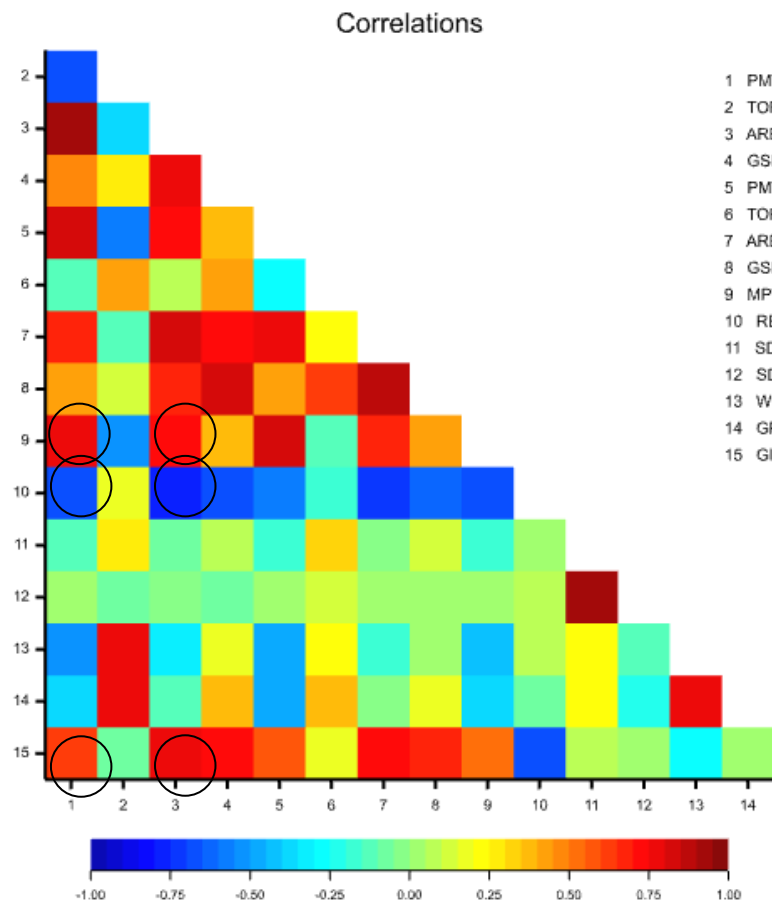
Prediction of Glutoppeak peak mixing time of semolina (PMT-S) and Area-S using wholemeal peak mixing time (PMT-WM) and Area-WM, $r^2 \sim 0.7$



Precision: WM 3.7% vs. S 5.2%



WM 3.4% vs. S 6.2%



1 PMT_
2 TORC
3 AREA
4 GSI_V
5 PMT_
6 TORC
7 AREA
8 GSI_S
9 PMT
10 RBD
11 SDS
12 SDS
13 WG
14 GP
15 GI

	MPT	RBD	GI	SDSS	GP
PMT-WM	0.77	-0.67	0.64	-0.12	-0.37
Area-WM	0.72	-0.78	0.78	-0.02	-0.12
PMT-S	0.80	-0.59	0.60	-0.15	-0.47
Area-S	0.66	-0.71	0.75	0.02	--0.06

Discriminating Power-CV across all data

Area-WM 26

PMT-WM 33

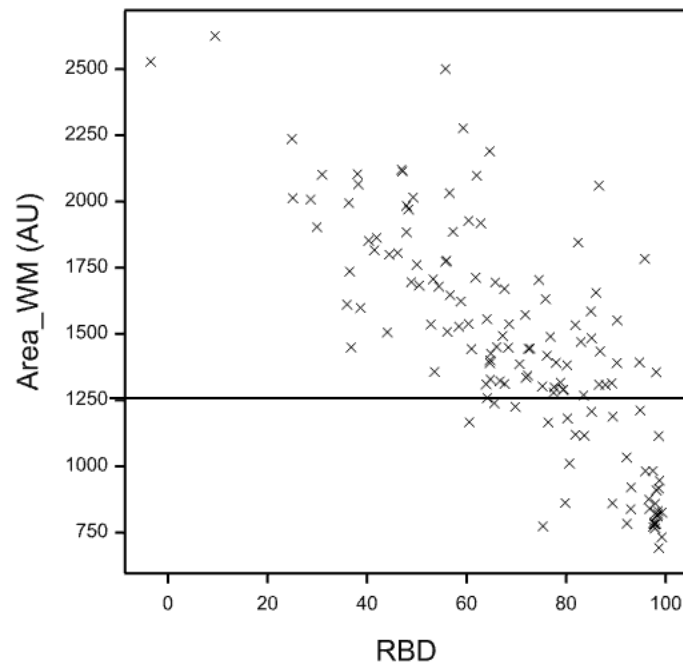
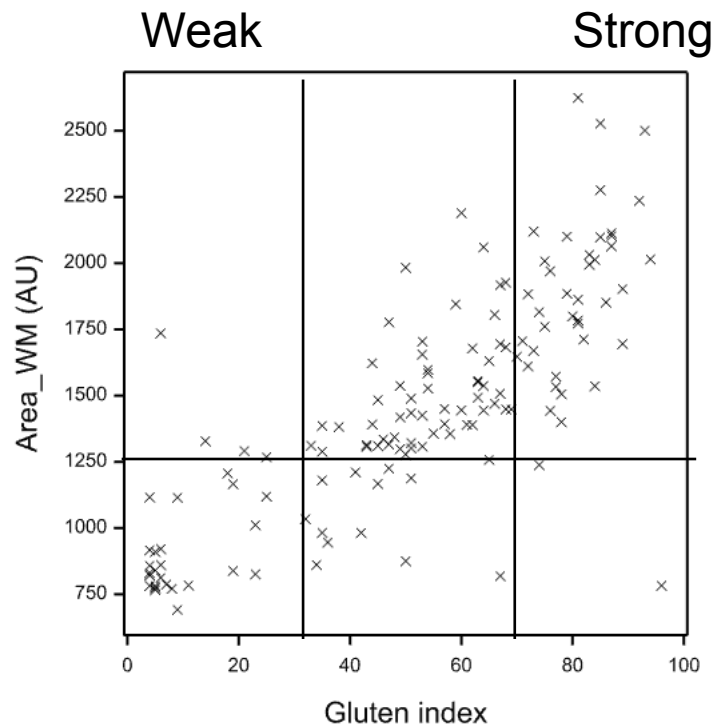
MPT 20

RBD 31

GI 44

SDSS 11

Relationship between gluten index or resistance breakdown as a reference index of gluten strength and Glutoppeak wholemeal Area





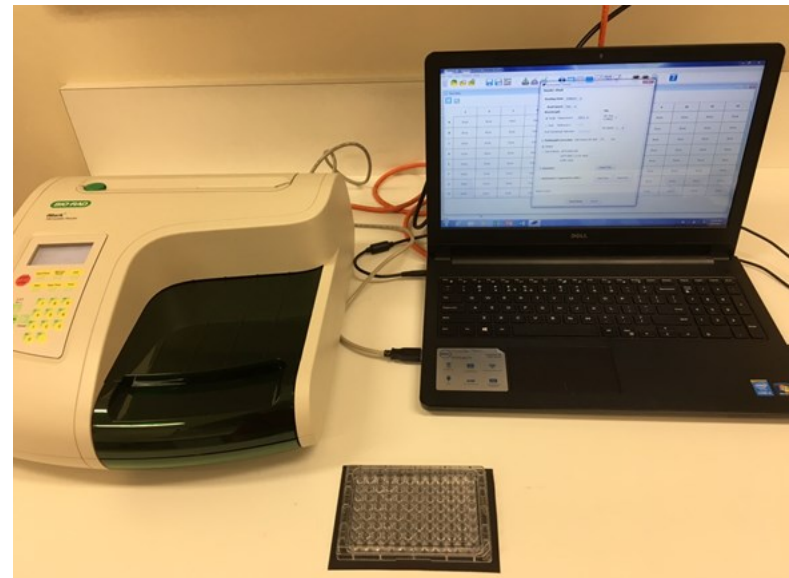
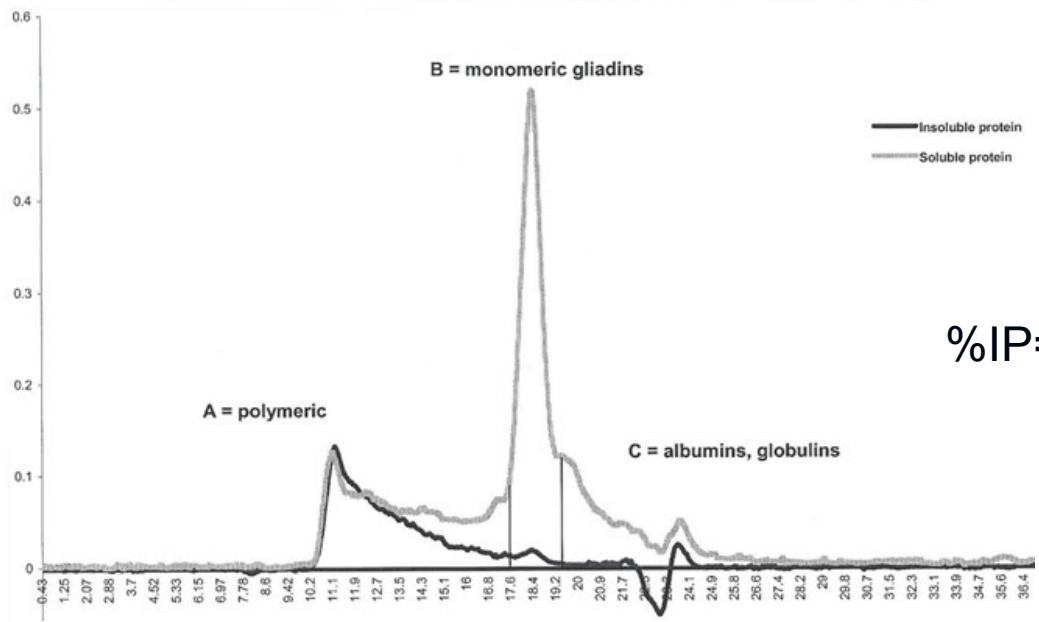
Correlation between GlutoPeak and the other rapid tests

Subset of samples (n=72s) tested for swelling index of glutenin (SIG), SE-HPLC of glutenins (UPP), proportion of insoluble glutenin in total polymeric protein (IP%) by turbidity to compare with GlutoPeak

Rapid small scale tests to predict semolina performance

40mg, duplicate analyses

$$\%UPP=100* \text{ insoluble A}/(\text{insol A} + \text{Soluble A})$$



$$\%IP=100x \text{ Av. Insoluble}/(\text{Av. insol}+\text{Av. sol})$$

Swelling Index of Glutenin



40mg semolina or wholemeal into pre-weighed tube
Add 0.6mL water, mix 20min



mix 20min

Add 0.6mL SDS Lactic acid



Centrifuge, remove supernatant, weigh tube

SIG as is = (Weight of tube plus gel – weight of tube)/sample weight.

Range in values

	Area-WM	UPP	IP%	SIG-S	SIG-WM
mean	1580	0.37	23.1	4.7	4.4
min	767	0.28	14.2	3.7	3.5
max	2501	0.47	32.8	6.1	6.9

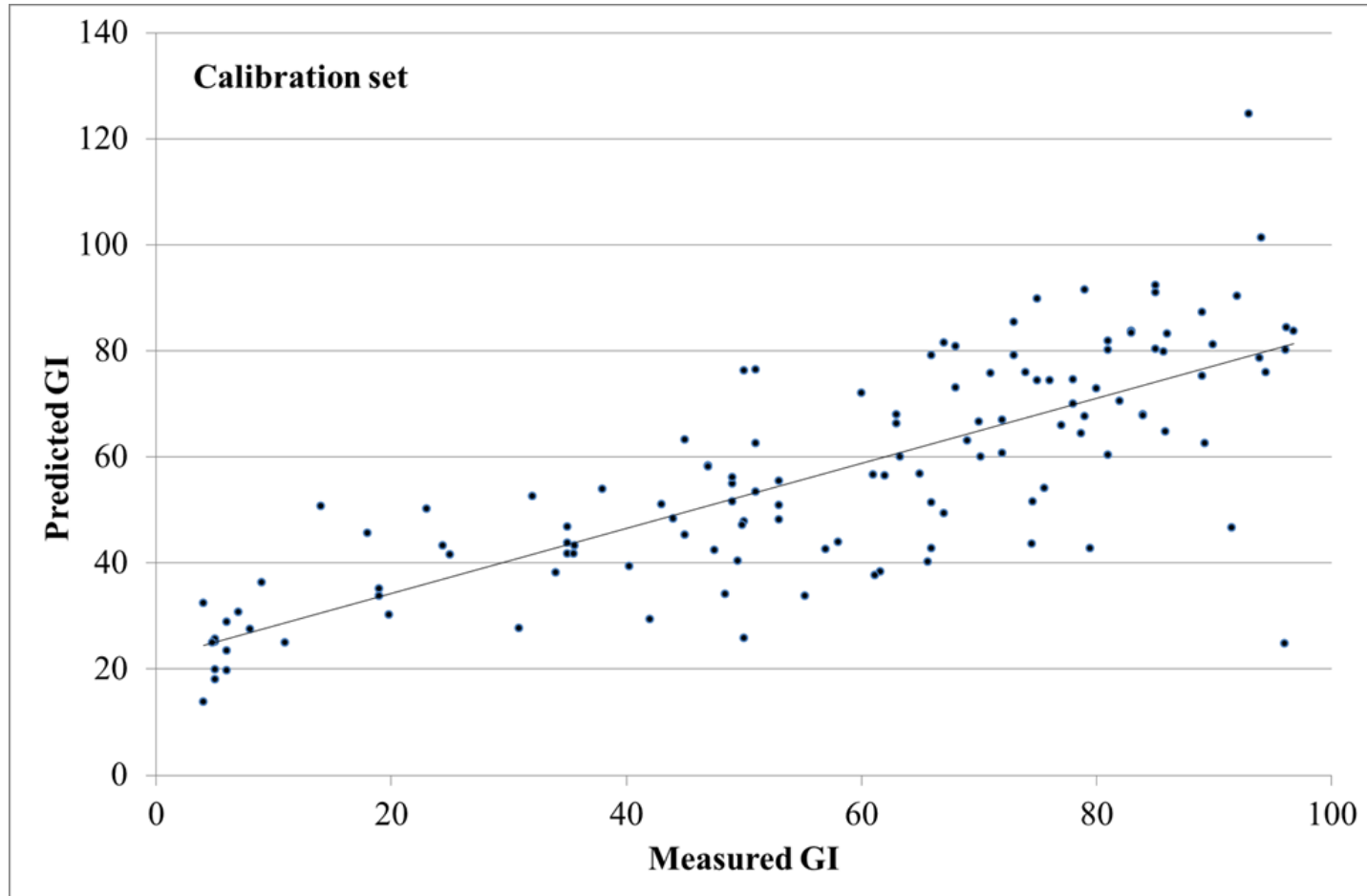
			Discriminating Power-CV across all data						
			Area-WM						
			PMT-WM						



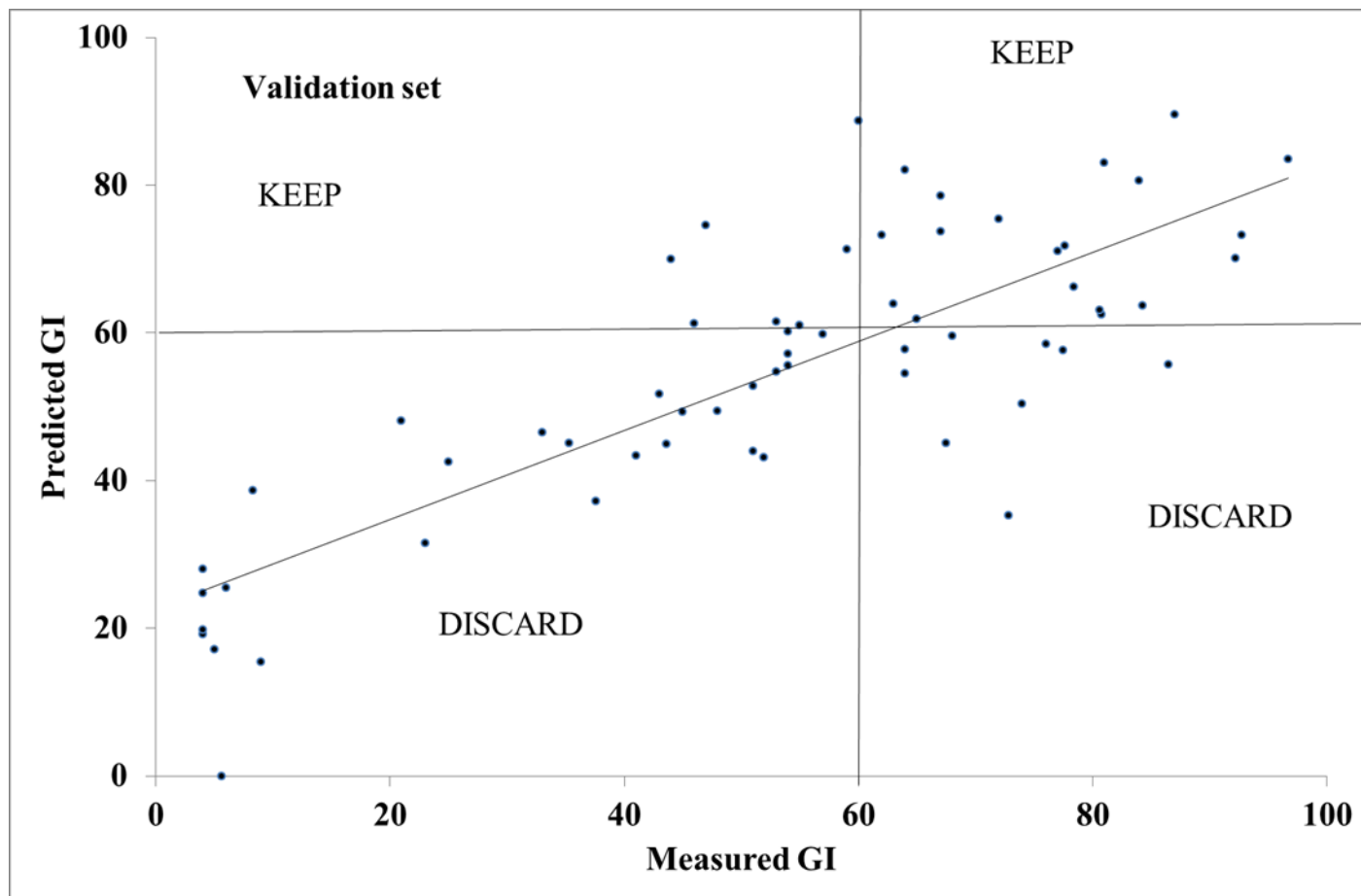
Can GlutoPeak predict strength on breeder's samples?

Breeders validation set of 64 samples tested by Glutopeak and GI predicted values obtained

Calibration model to describe prediction of gluten index from Area-WM



$$GI = 0.0506 \times \text{Area-WM} - 49.85$$



Is the GlutoPeak instrument useful for screening durum for gluten strength?

- Uses 9g wholemeal; low cv 3-4%, result in 5min
- Must grind samples with same mill
- Useful to screen out low-moderate gluten strength
- Better than biochemical methods unless sample size is very limited
- Further validation with application to breeders samples needed

Acknowledging the cereal team



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