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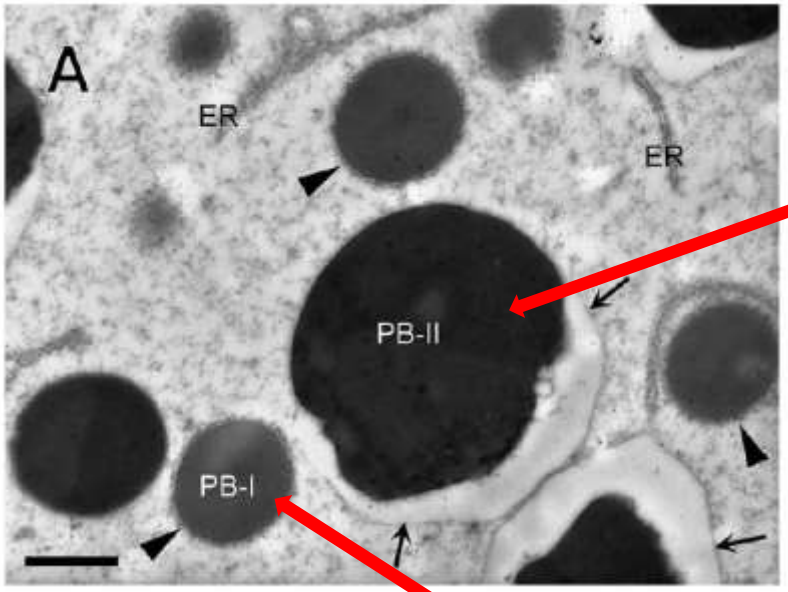
The role of protein in rice quality

Dan Waters

Rice grain proteins

Defined by solubility differences



Ashida et al.
Breeding Science
61: 201–207

- PB-II

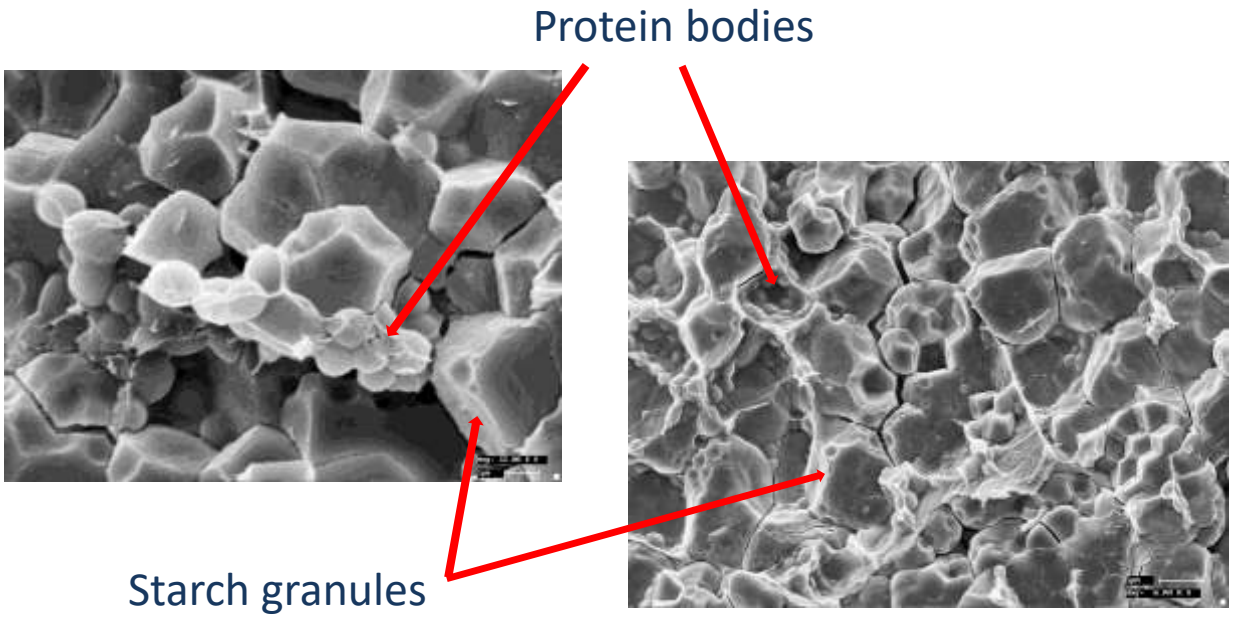
→ globulins, salt soluble
~5-10% of rice grain, ~5% of wheat grain

→ glutelins, dilute acid/alkali soluble
~65-80% of rice grain, ~40% of wheat grain

- PB-I

→ prolamins, alcohol soluble, poorly digested
~10-20% of rice grain, ~55% of wheat grain

Rice grain proteins

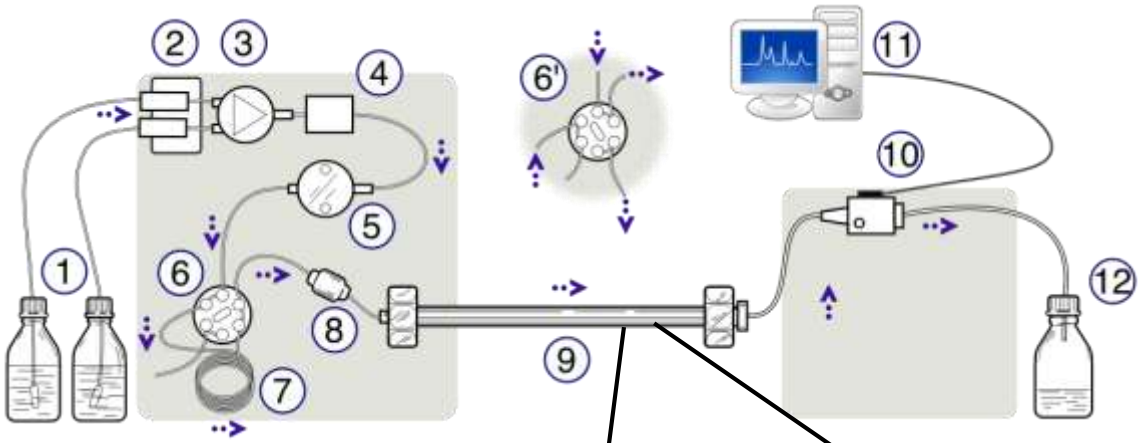


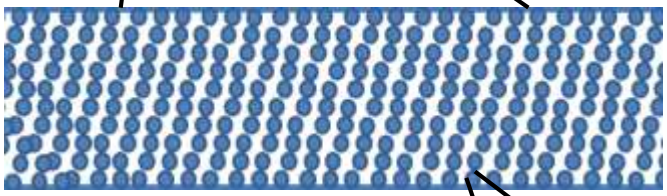
Kasem et al.
Rice 4: 12-20

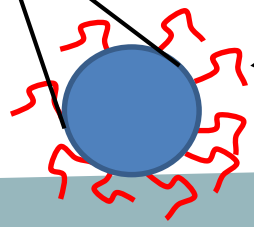
- Subtraction-addition experiments -> amount and ratio of each type of protein influences rice flour and grain properties differently

- Do rice cultivar differences in grain protein composition influence rice grain quality?

HPLC analysis

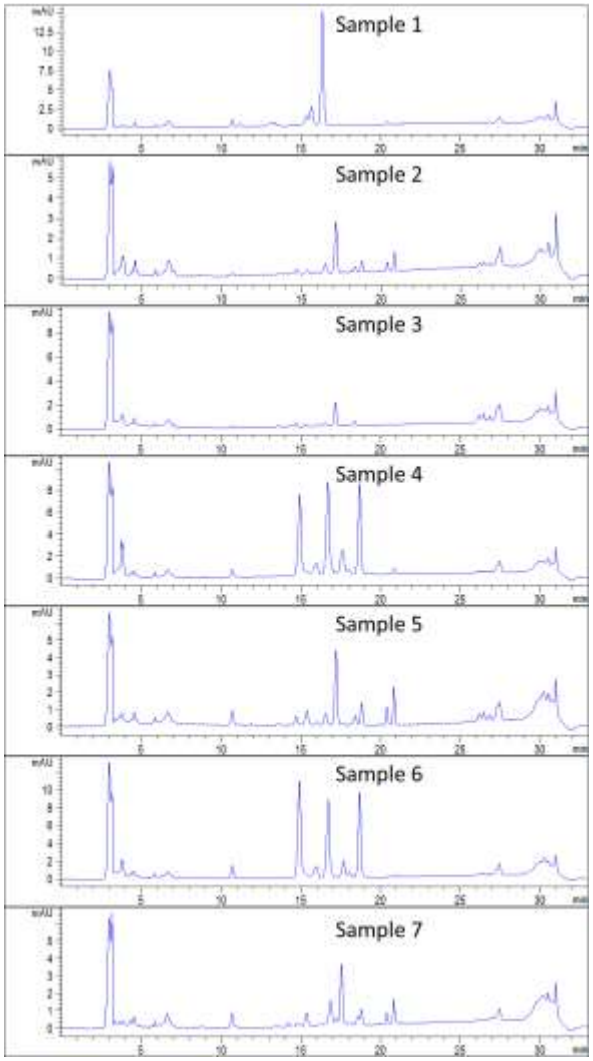




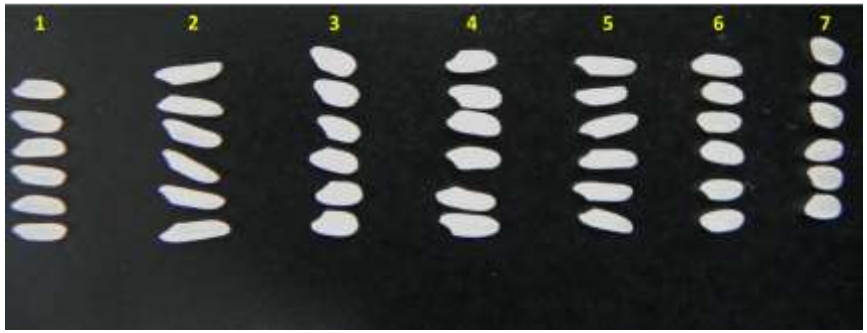


"Fatty" chains
C4, C8, C18

Rice grain HPLC prolamin profiles



- Qualitative and quantitative protein composition differences



Samples analysed

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- 2013 QEP samples: 149 16-20% amylose samples, long and medium grain.
High proportion of broken grain samples. 20 “Sushi” cultivars - local and international.

- 2014 QEP samples: 80 long and 80 medium grain 17 -20% amylose samples.

- 2016 QEP samples: 80 17 -20% amylose medium grain samples.

- Protein composition correlated with QEP data.

Sushi prolamins and RVA setback

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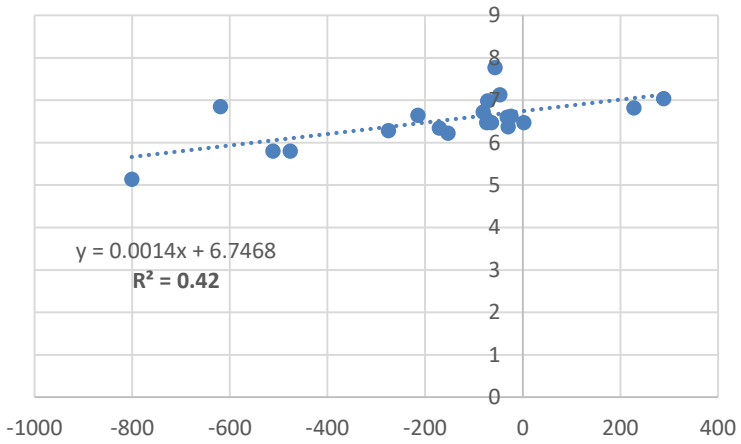
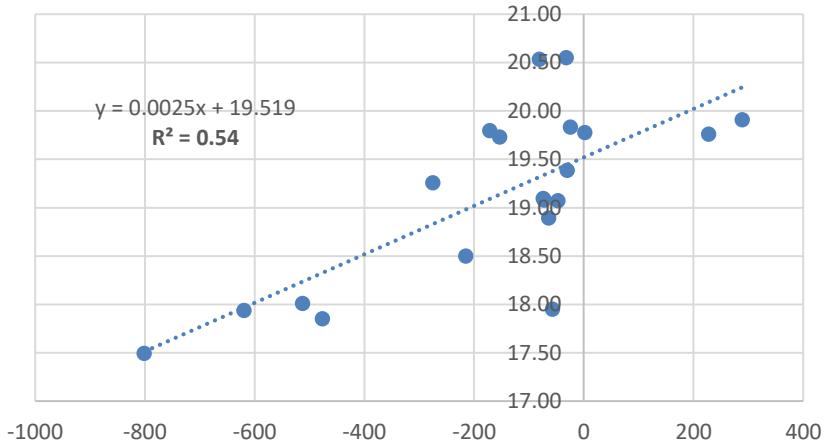
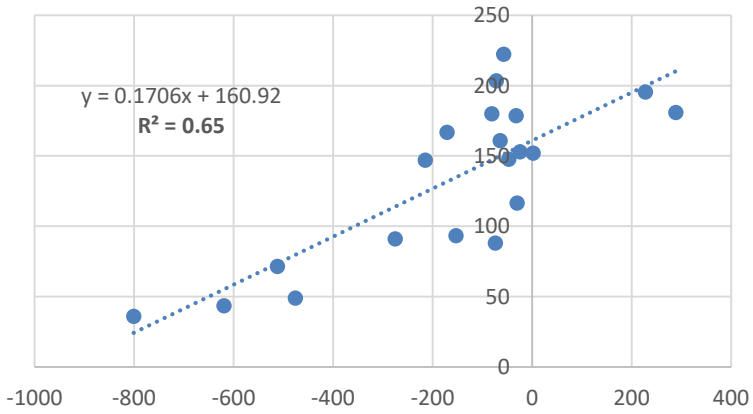
Total protein



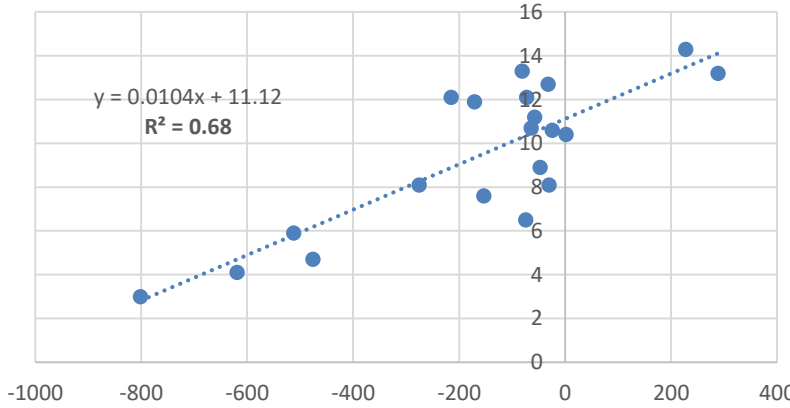
% Amylose



Total prolamin



Prolamin peak 26



2014 QEP long and medium grain

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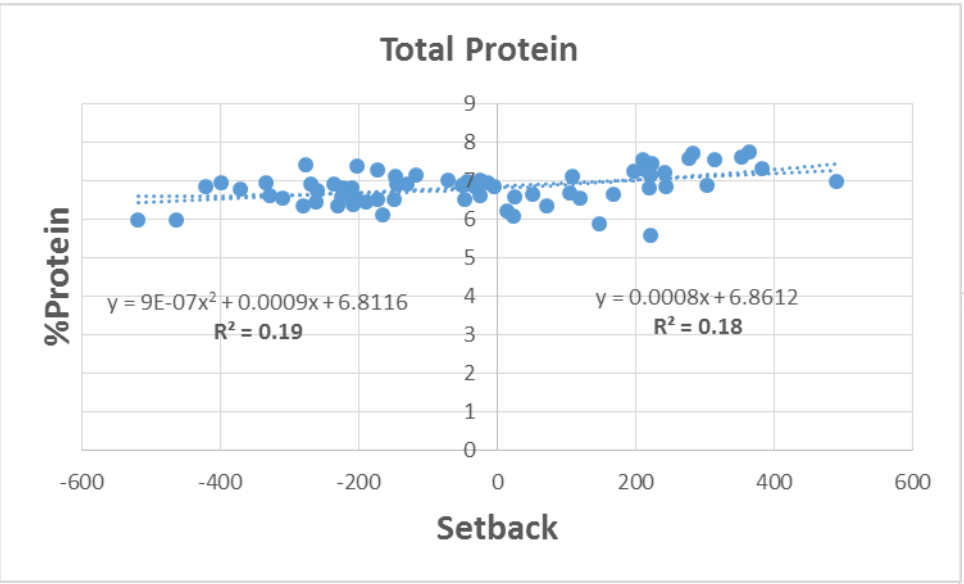
- HPLC protein profiles of 80 long grain and 80 medium grain lines and cultivars of 17% - 20% amylose correlated (≤-0.5 or ≥0.5) with texture parameters

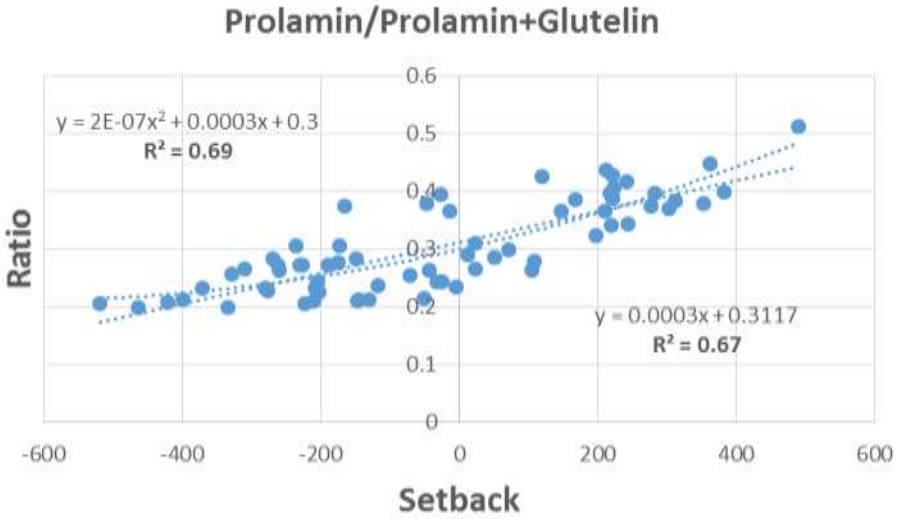
- Albumin and globulin displayed very low levels of variation

	Long grain Profile 1	Long grain Profile 2	Medium grain Profile 1	Medium grain Profile 2
# Samples	53	27	67	13
% Protein	6.3 - 10.3	6.4 - 8.5	**5.6 - 7.8**	5.5 - 9.8
Pasting Temp (ºC)	68 - 77	67-78	**66 - 69**	66 -76
RVA correlations	Prolamin	NS	Prolamin	Protein (prolamin)
TA correlations	Glutelin	NS	Prolamin (1)	Glutelin

2014 QEP medium grain Profile 1



- Prolamin / Prolamin + Glutelin ratio a better predictor of Setback (cooked rice firmness) than Total Protein and Prolamin (R^2=0.44)



2014 and 2016 QEP medium grain Profile 1

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- Mean/population protein composition differed between years

Year	Total globulin mean AUC; CV	Total prolamin mean AUC; CV	Total glutelin mean AUC; CV	Prolamin/ Prolamin + Glutelin ratio mean; CV
2014 MG-Profile1 (67 samples)	466; 8	**248; 29**	583; 24	**0.30; 26**
2016 MG-Profile1 (61 samples)	316; 10	**148; 34**	670; 17	**0.18; 27**

2014 and 2016 QEP medium grain Profile 1

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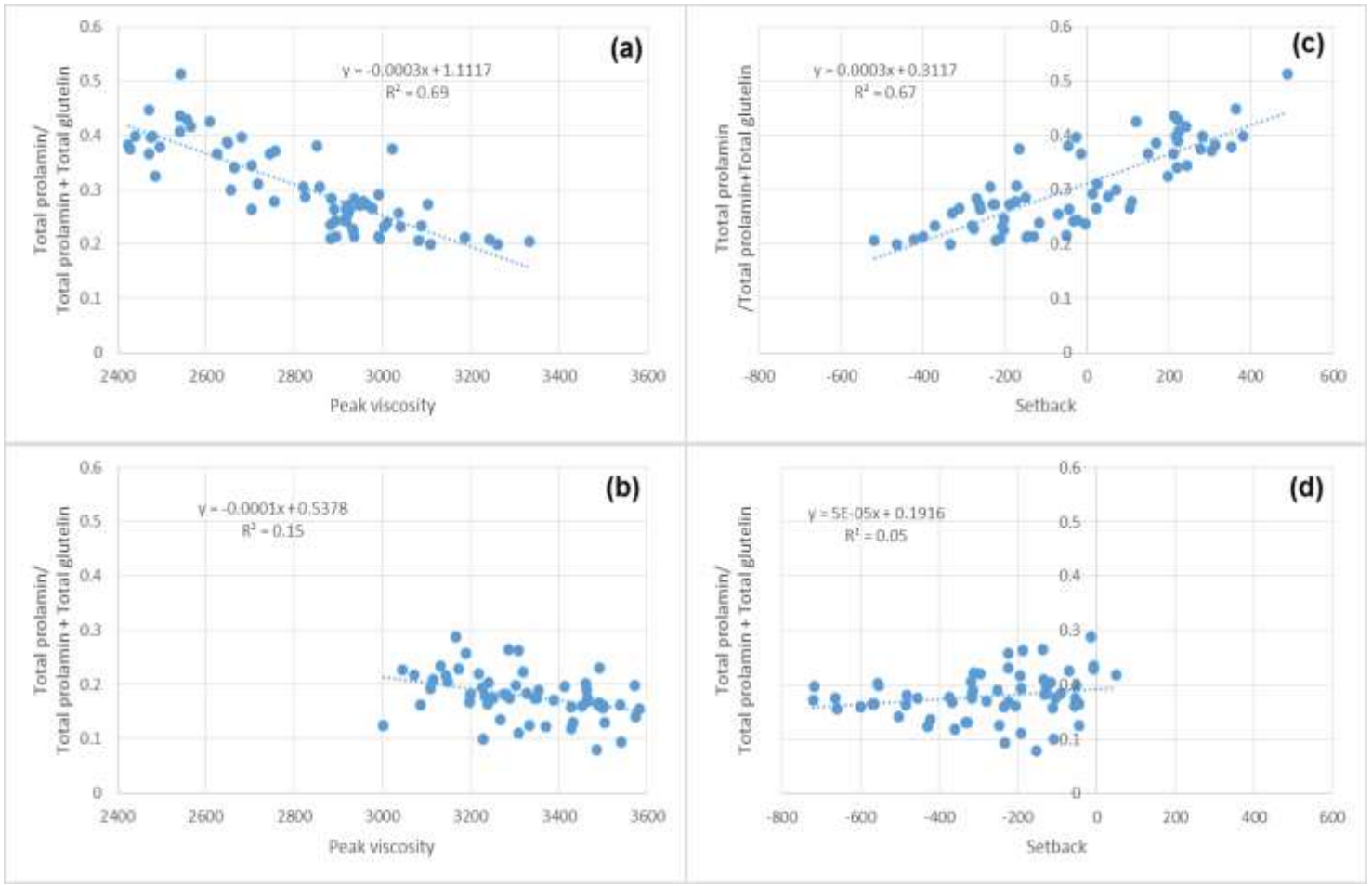
2014

2016



2014 and 2016 QEP medium grain Profile 1

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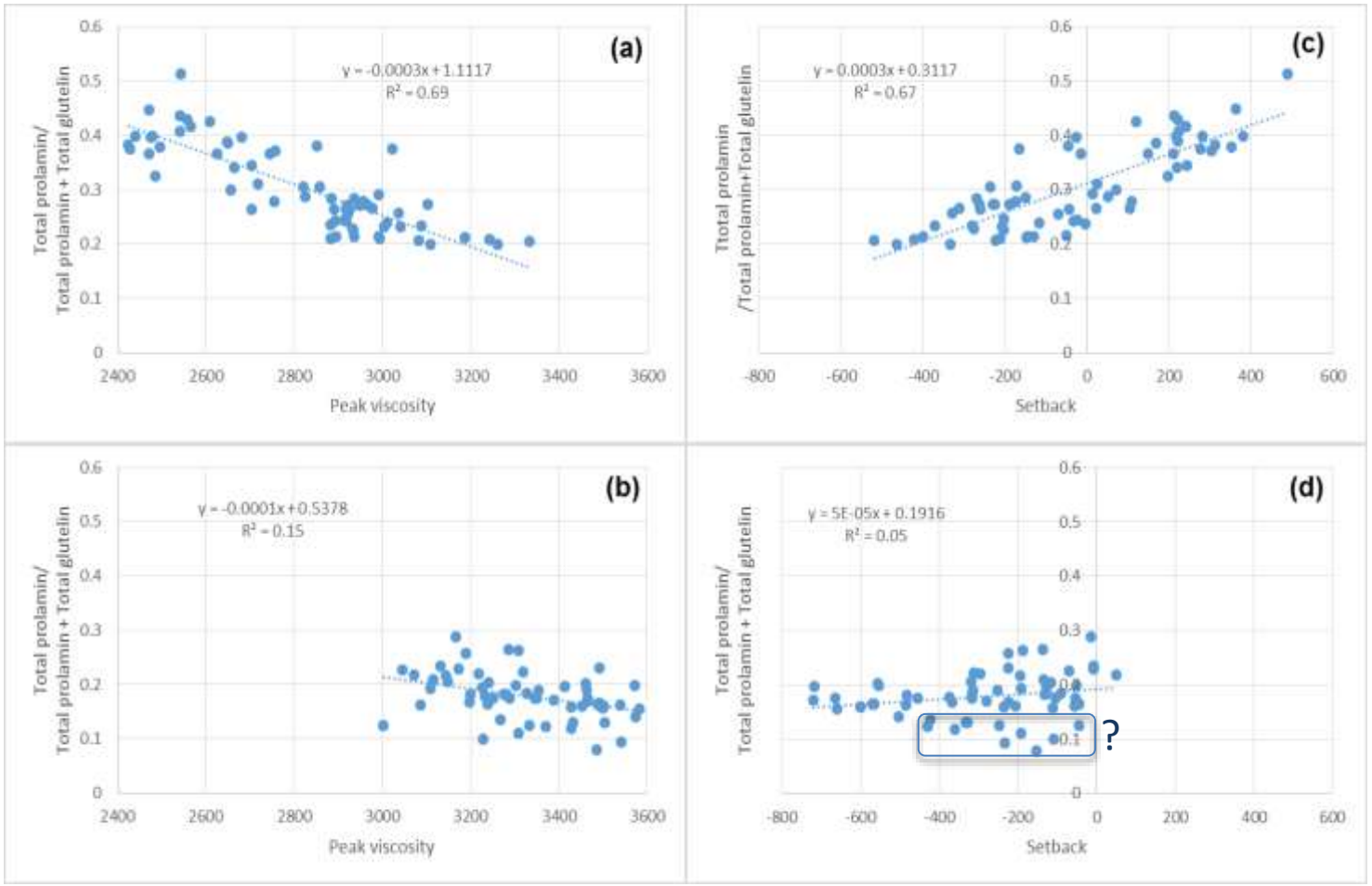
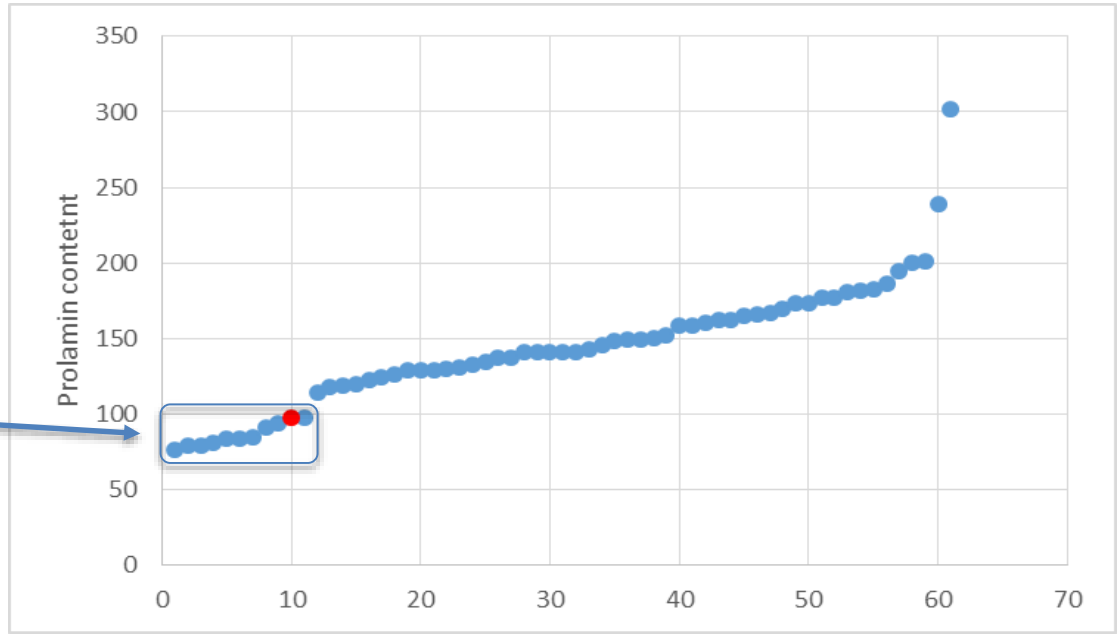
2014

2016



2016 QEP medium grain Profile 1

- Tachiminori x 2
- Jyoudeki x 2
- Koshihikari x 2
- Sasanishiki x 2
- Calhikari x 2
- Amaroo x 1



- Japanese reference (in Japanese) -> high quality associated with low PB-I (prolamin) content

2013 samples

- 149 16-20% amylose samples, long and medium grain.
High proportion of broken grain samples.

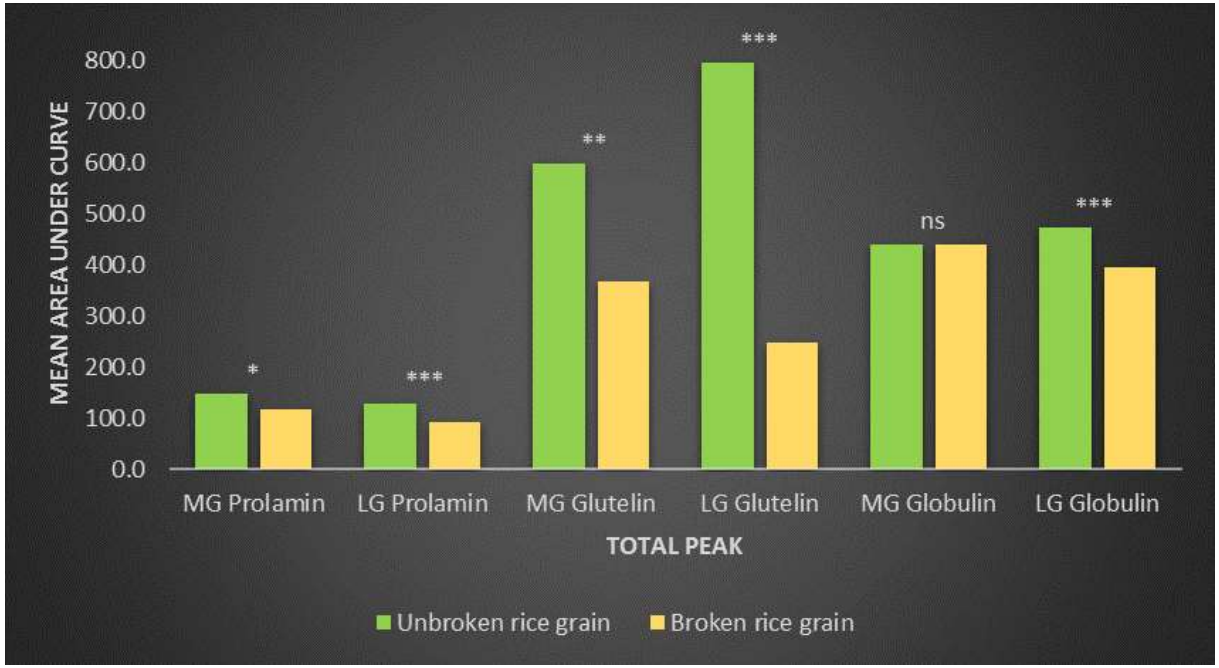
- Correlations weak when:-

    - Long and medium grain data analysed together

    - Broken grains included; protein composition dependent?

Grain breakage

Unbroken vs broken grain



Protein type	MG % Difference	LG % Difference
Total prolamin	-21%	-27%
Total glutelin	-39%	-69%
Total globulin	0%	-16%

Grain breakage – Medium grain

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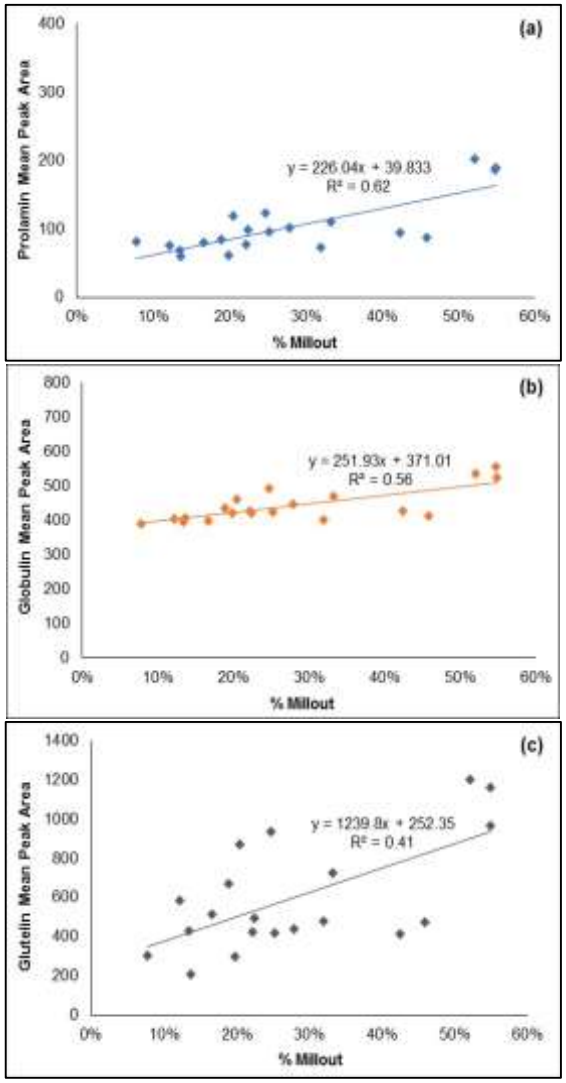
Unbroken grain



Globulins are the least variable fraction but strongest discriminator between unbroken and broken grains followed by prolamins

Discriminant analysis ten most significant variables

Glob 16	0.22879
Glob 17	0.08532
Glob 15	0.05590
Glob 14	0.04199
Glob 3	0.02928
Glob 6	0.02510
Prol 6	0.02291
Prol 8	0.02170
Prol 9	0.02057
Glob 10	0.01905

In summary

Protein composition is a background dependent part of the rice grain quality puzzle

- A component of medium/short grain texture
- Plays a role in long grain texture but not as prominent as in medium/short grains
- Associated with grain breakage
- Possible interaction with and between grain breakage, grain texture and grain size

Acknowledgements

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NSWDPI rice breeding and quality program