



Ultra-low gluten barley—Kebari™

Crispin Howitt

CSIRO AGRICULTURE AND FOOD

www.csiro.au



Gluten-free food and beverage



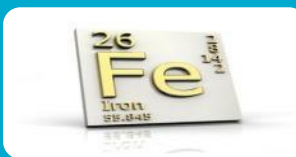
Coeliac disease requires a life-long gluten-free diet



The gluten free market is 10X larger

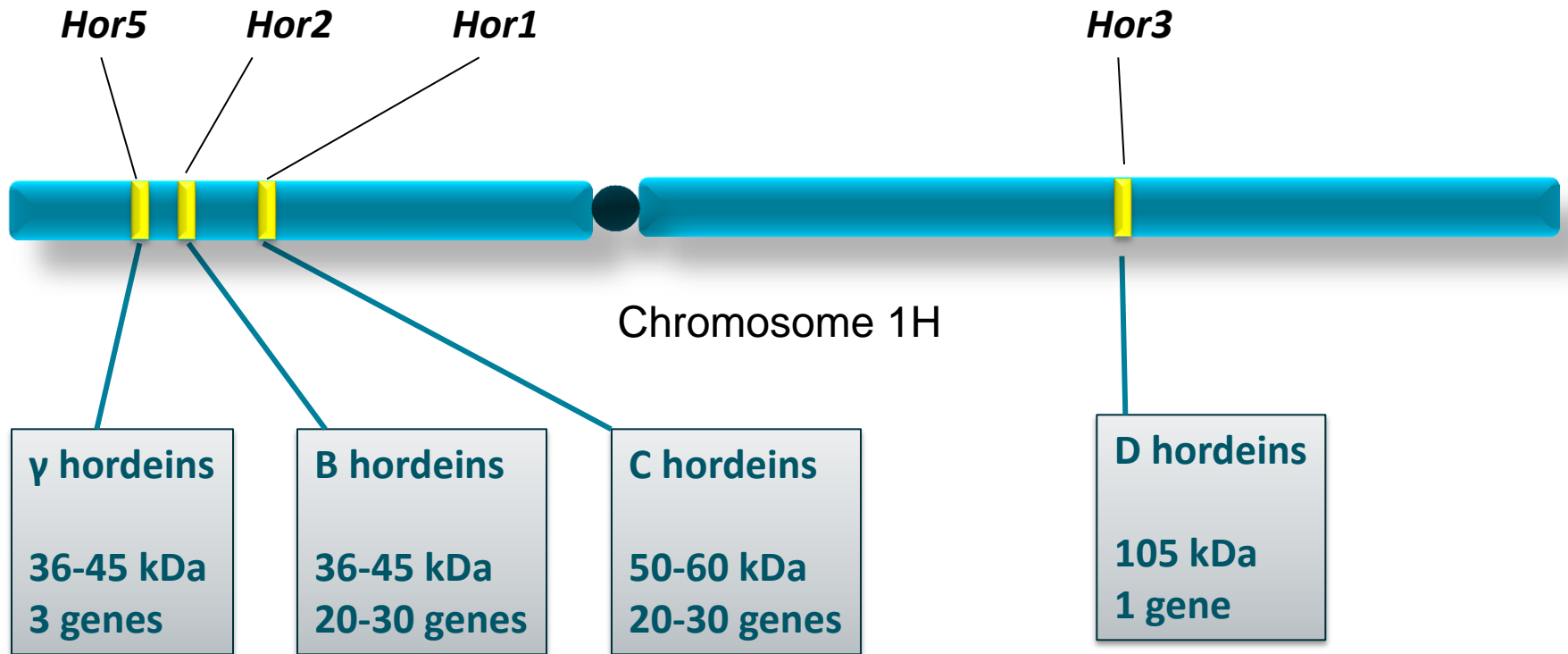


Worldwide market is \$10-14 billion and growing



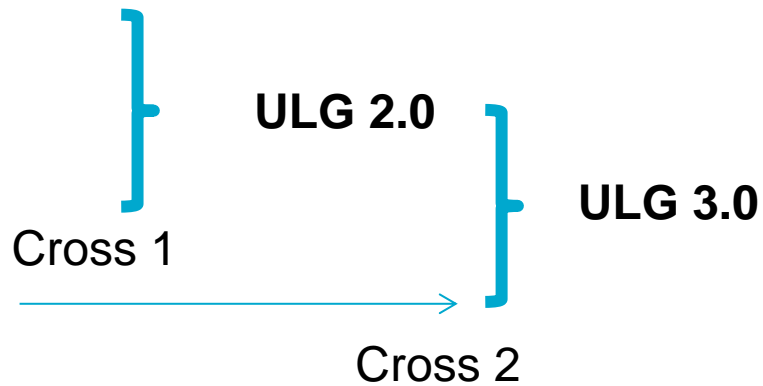
Growing recognition that gluten-free foods are poor in B vitamins, Fe and fibre

Gluten in barley - Hordein loci



ULG Barley – The Strategy

Hordein Class	Amount	Mutant
B	65-70 %	✓
C	25-30 %	✓
D	2-5 %	✓
γ	1%	✗



ULG Barley – Questions

- Can these be combined to create a ULG barley?
- How low can the gluten content go?

Are the plants viable?

If so, are they suitable for traditional products?



Development of ULG Barley



Sloop

~50,000 ppm
Grain 53 mg



ULG 2.0
June 2006

~1,600 ppm
Grain 33 mg

ULG 3.0
June 2009

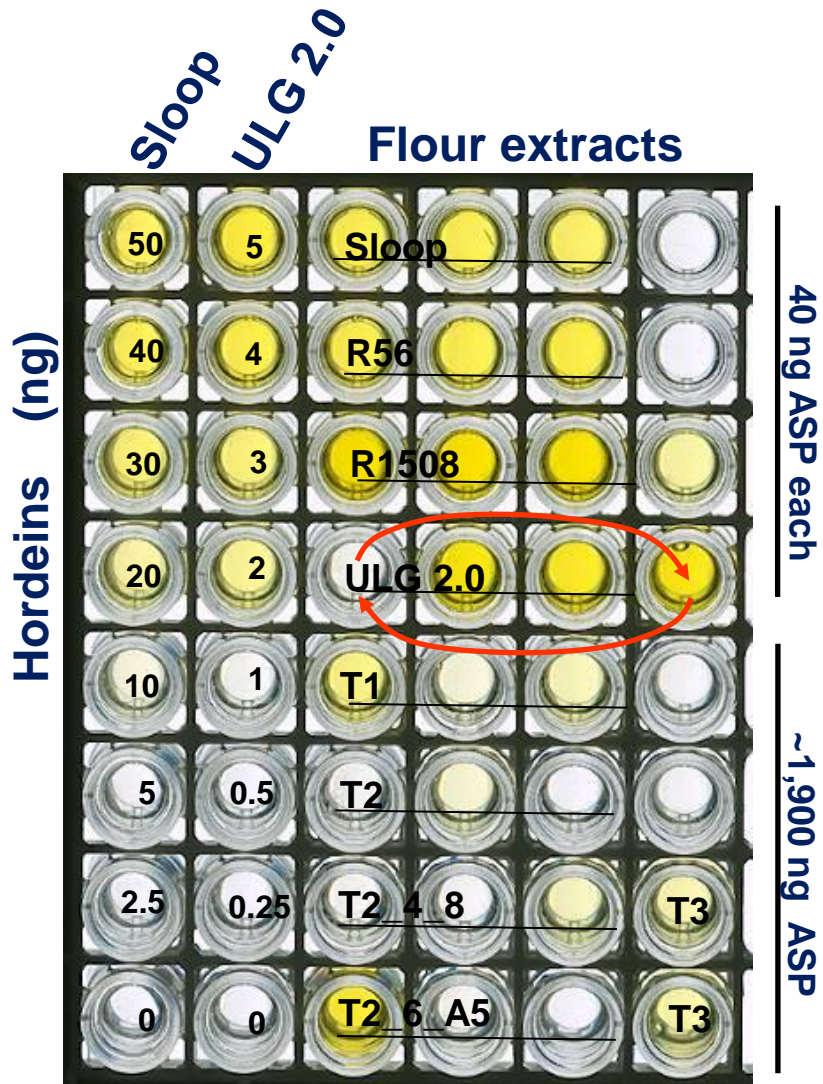
~4 ppm
Grain 42 mg

Unexpected suppression of γ -hordeins

**ULG 3.2
June 2012**

**<4 ppm
Grain 48 mg**

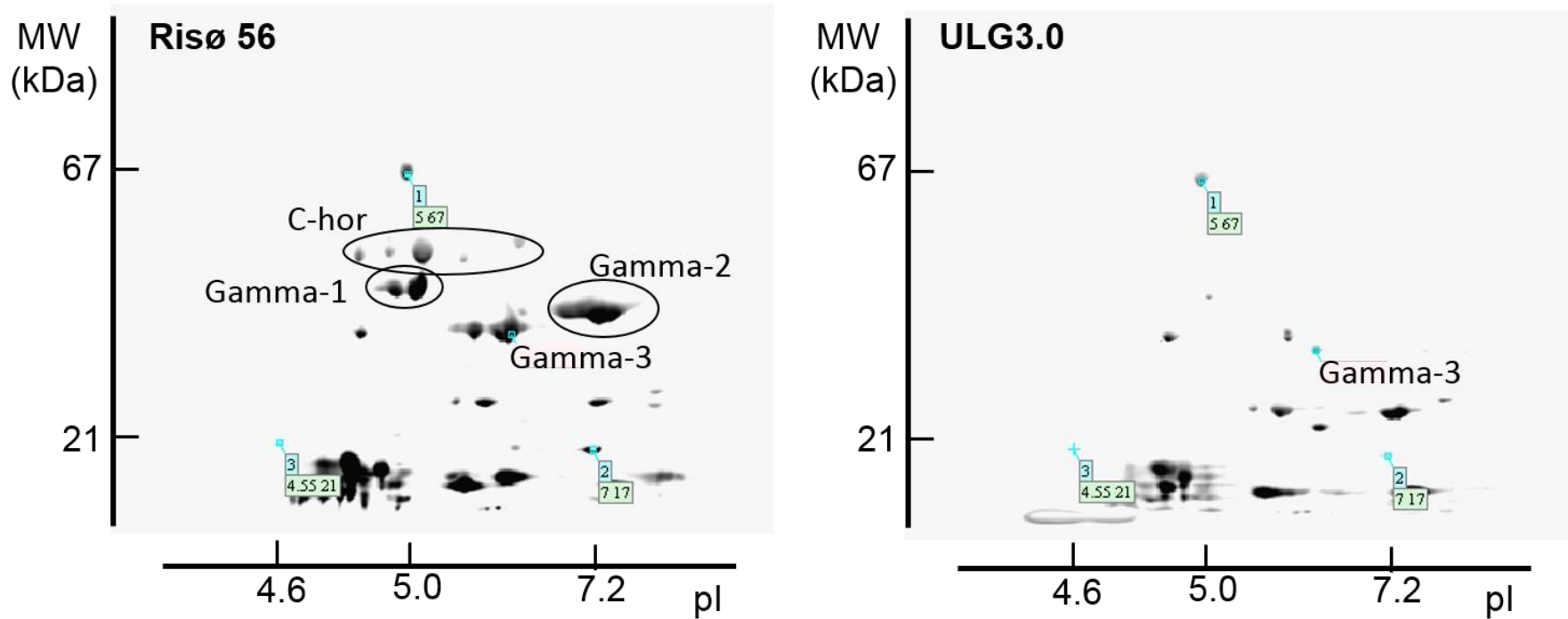
ELISA determination of hordein



Line	Hordein ppm in flour
Sloop	56,600 ± 3,300
R56	33,300 ± 1,100
R1508	4,900 ± 260
ULG 2.0	1,670 ± 70
ULG 3.0	3.9 ± 1.7
T2_6_A5	1.5 ± 0.4

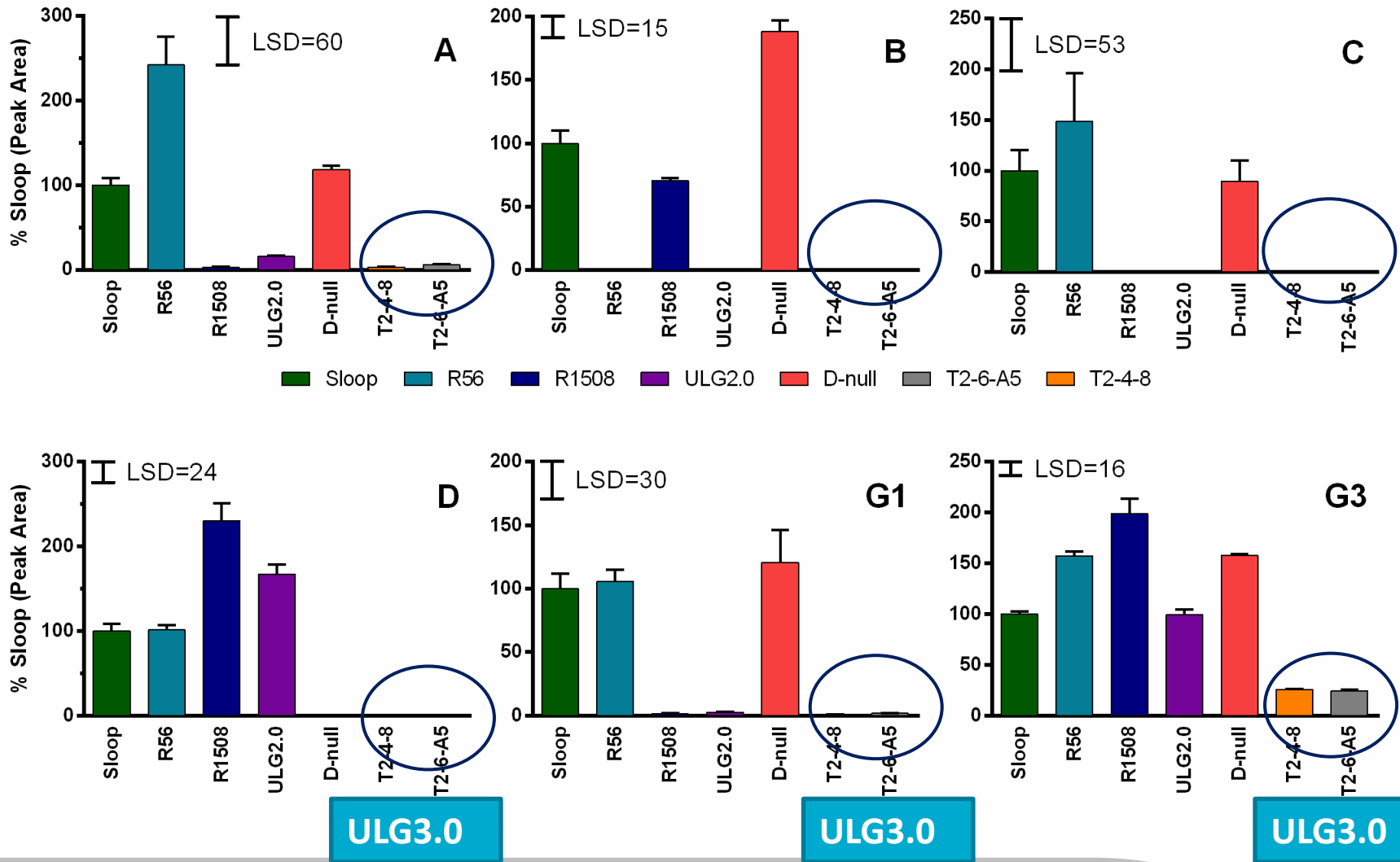
ULG 3.0 ~4 ppm in flour

Hordein content by protein densitometry

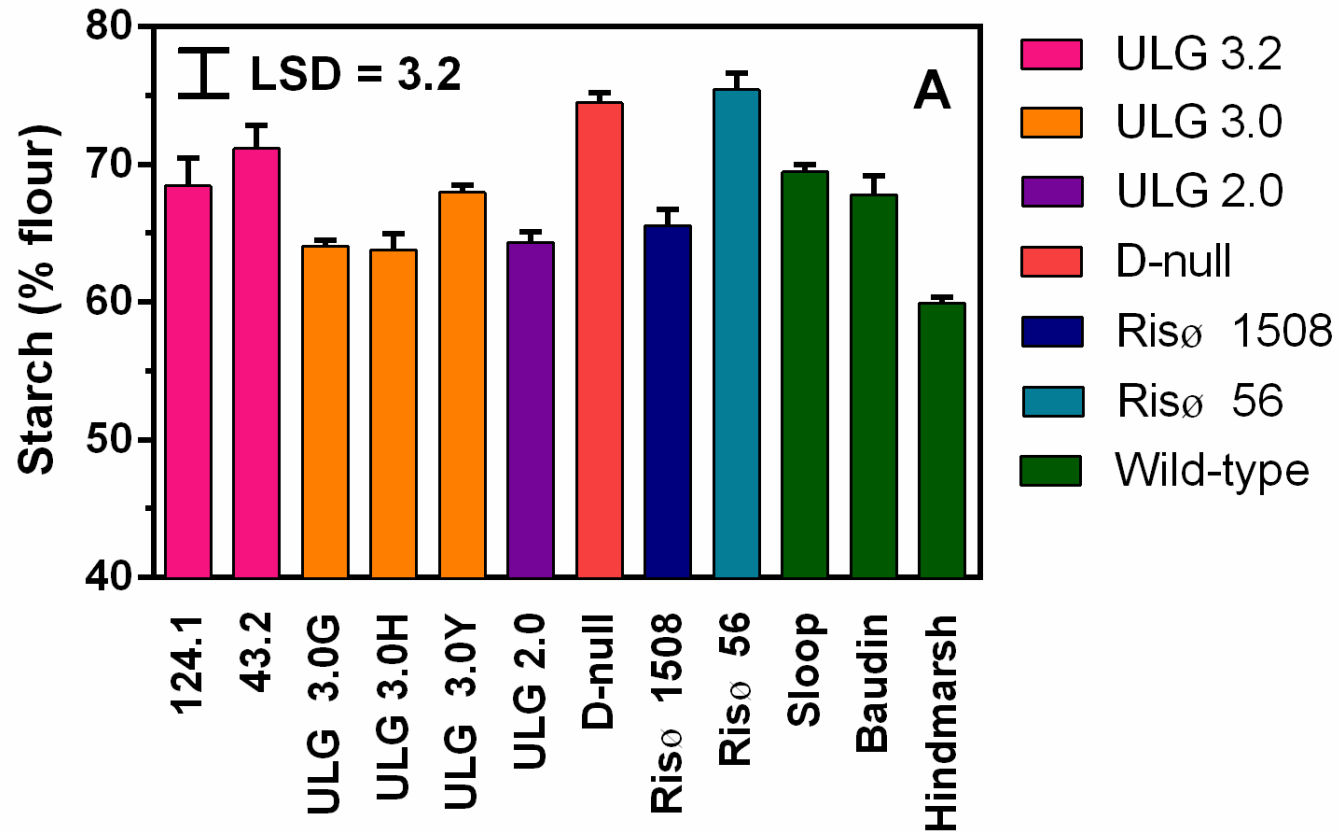


- 5 -13 ppm depending on the method used

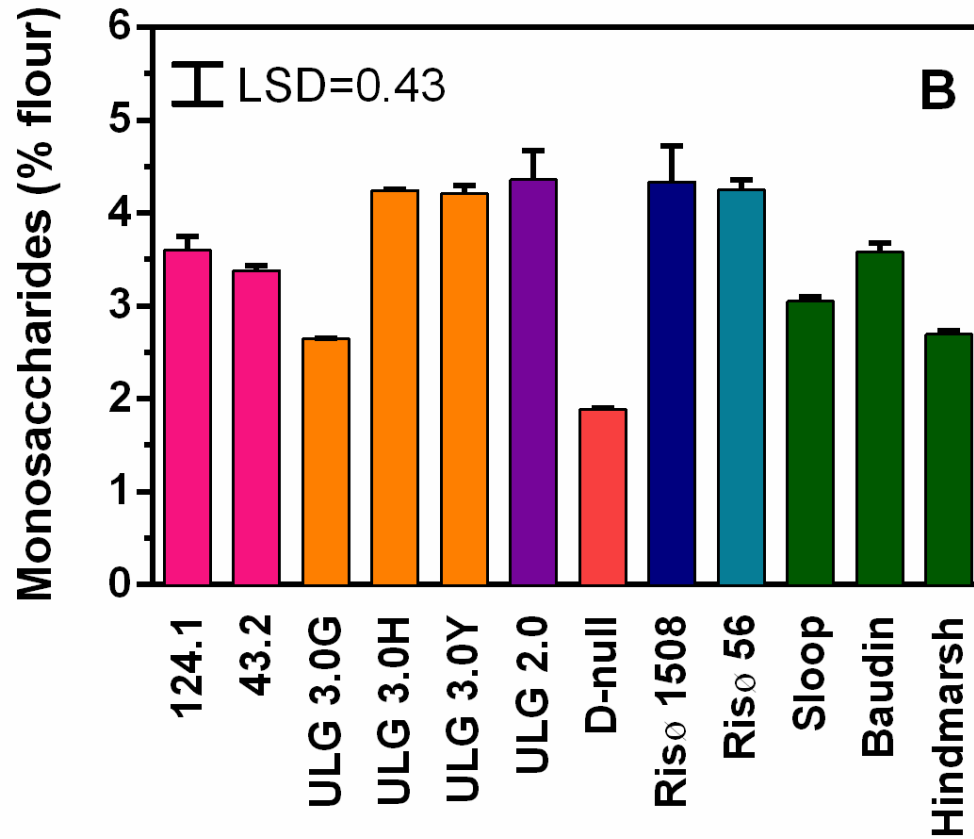
Mass Spec. analysis of ULG3.0 flour



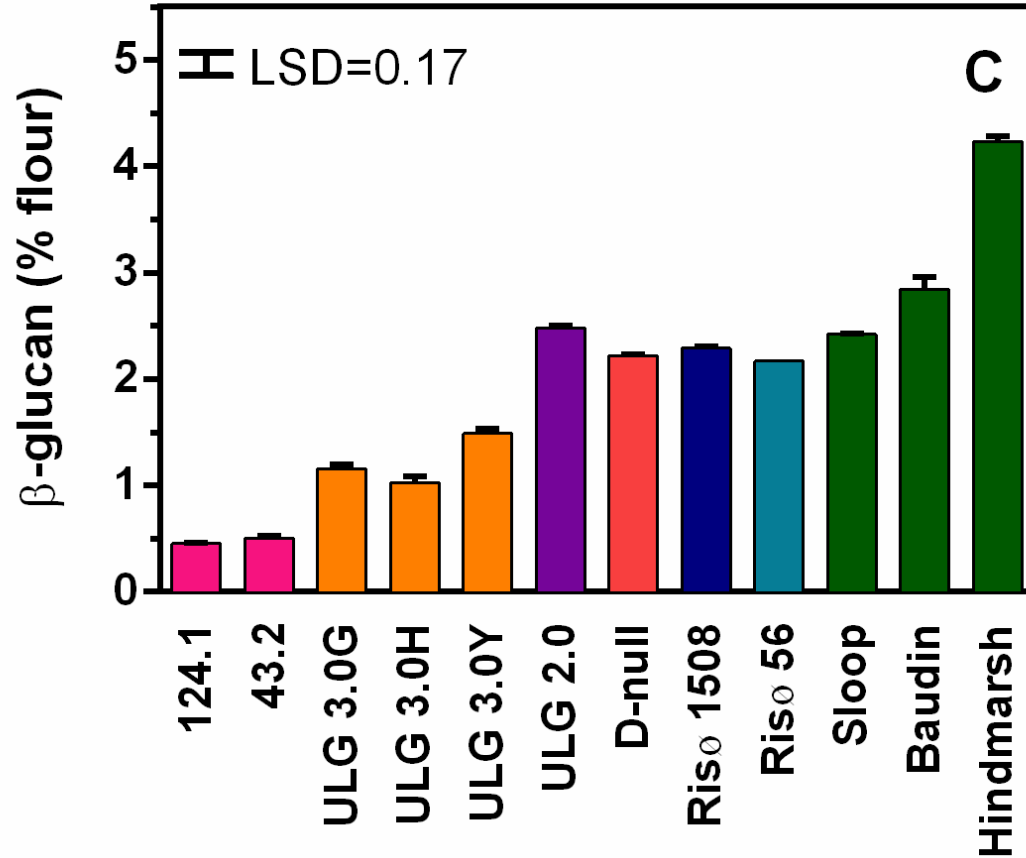
Starch Content



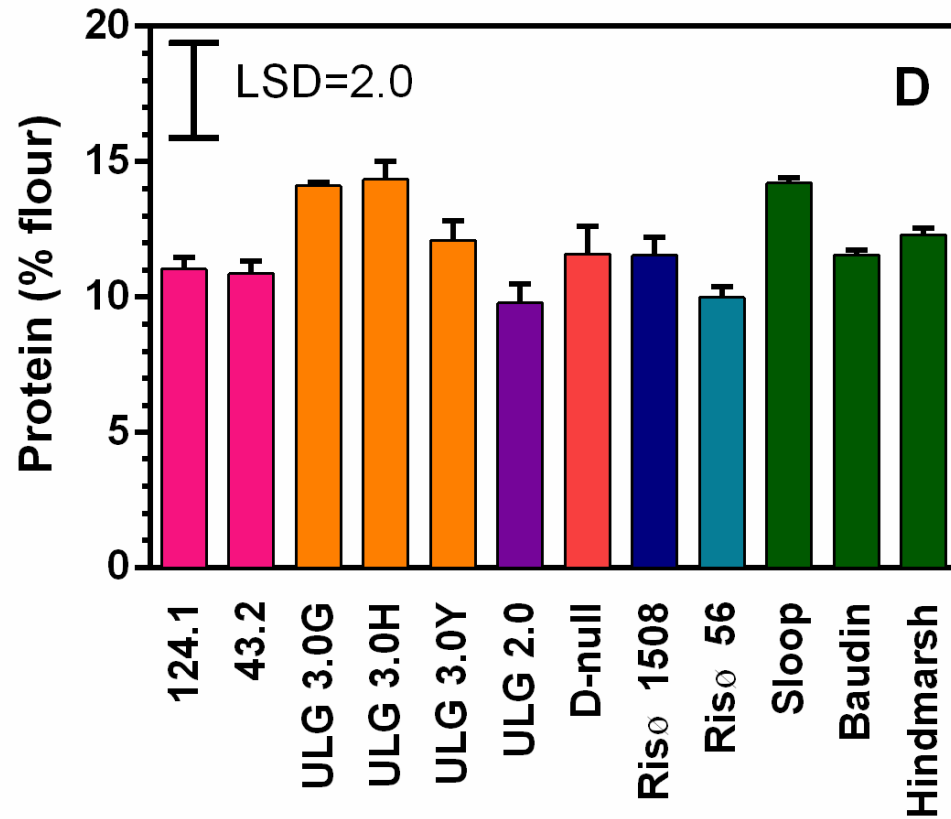
Monosaccharide Content



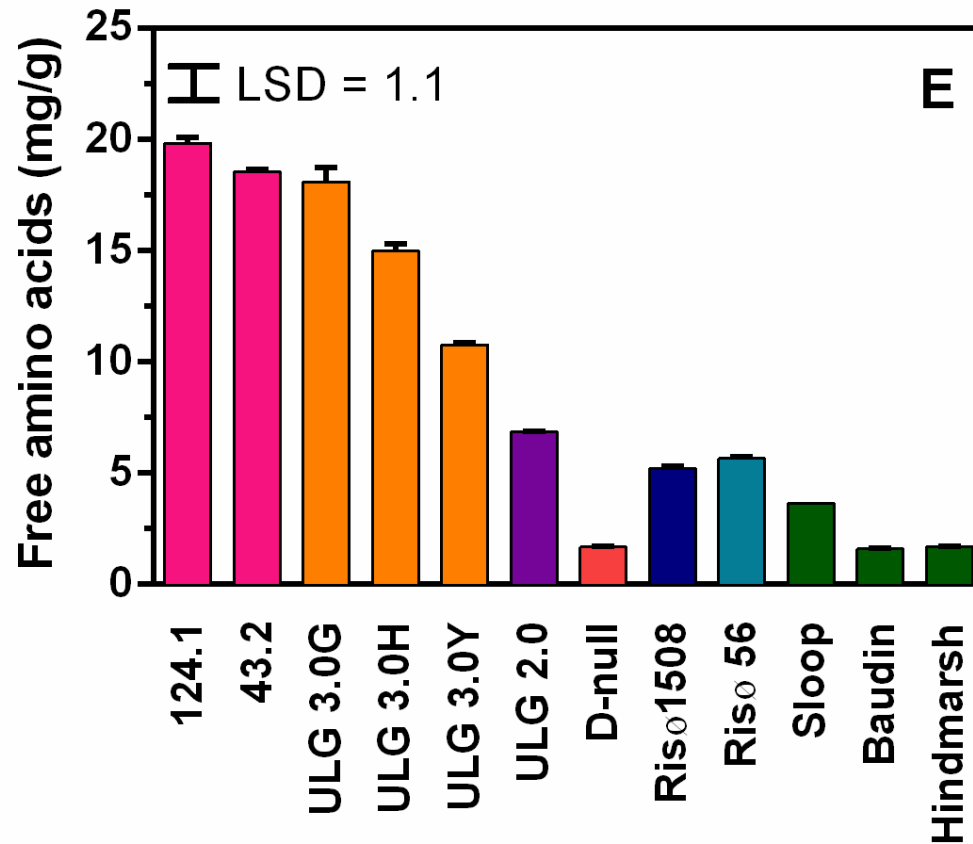
β -glucan content



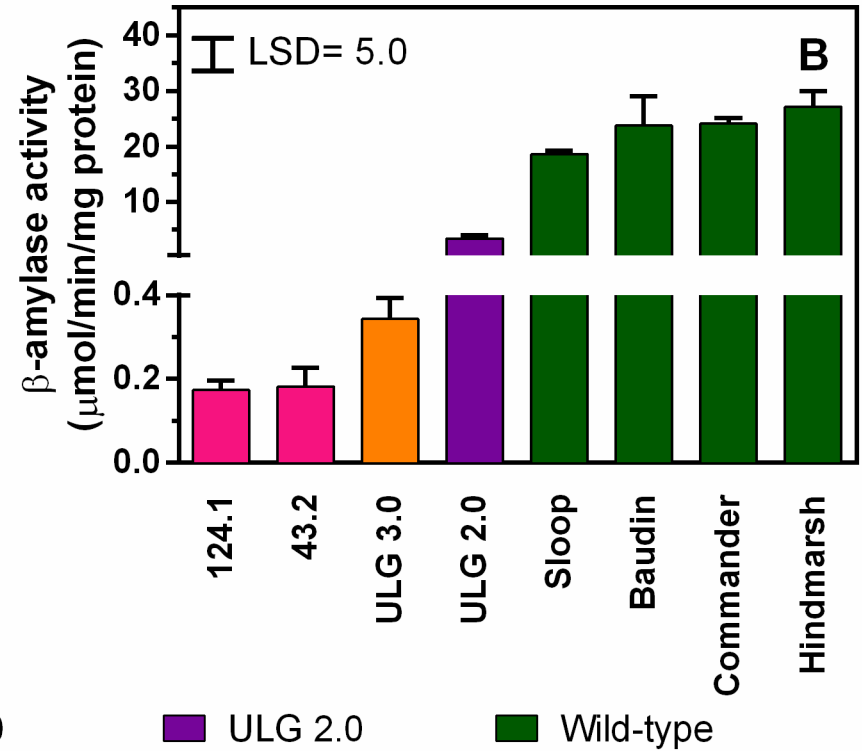
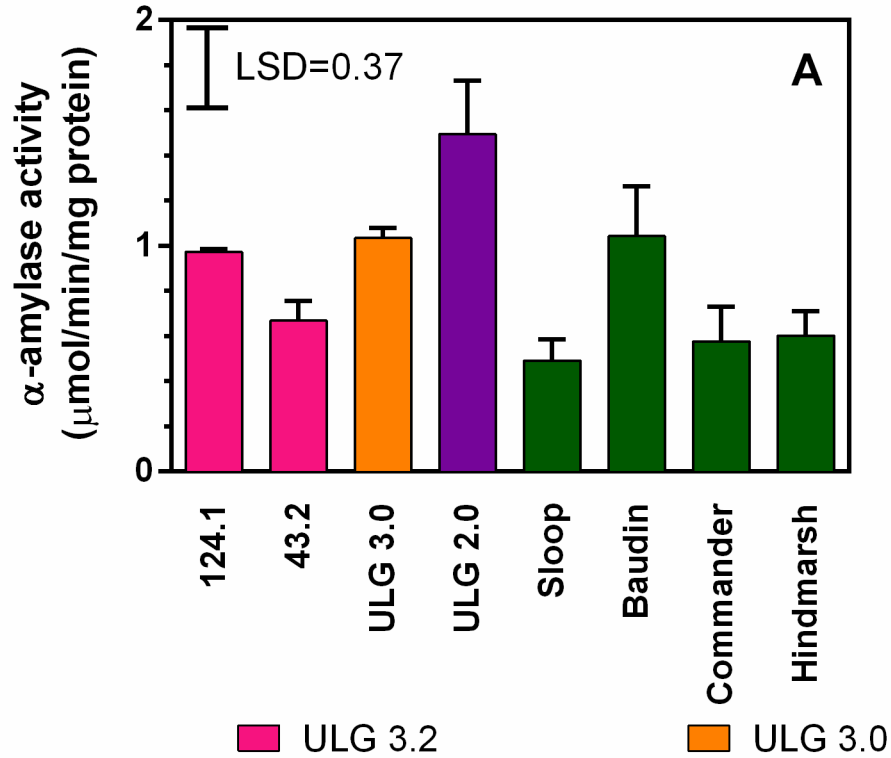
Protein content



Free amino acid content



Amylase activity



Commercial release April 2016



ULG Barley Conclusions

- Production of ULG barley is viable
- Gluten content is below 10 ppm
- Beer has been launched commercially
- Versions with larger grains have been developed
- Hull-less version for food applications has been developed



Acknowledgments

CSIRO

Greg Tanner

Malcolm Blundell

Russell Heywood

Michelle Colgrave

Harry Goswami

Thank you

- **CSIRO Agriculture and Food**

Crispin Howitt

Crispin.Howitt@csiro.au