

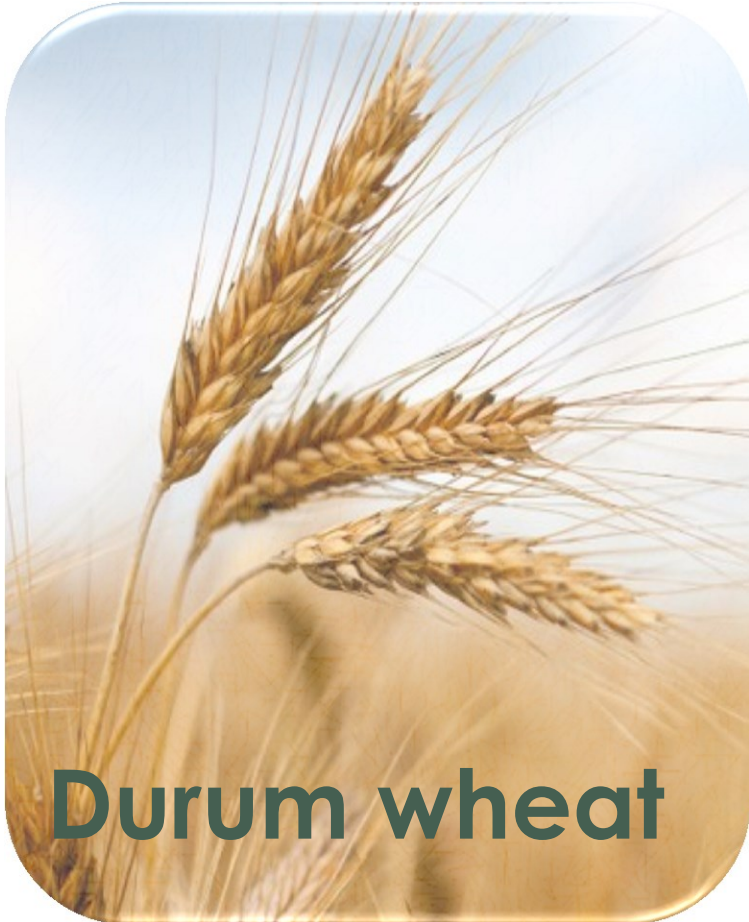
Grain quality traits of commercial durum wheat varieties and their relationships with drought stress and glutenins composition



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Anayeli Morales, Héctor González,
José Crossa, Carlos Guzmán

Introduction



Durum wheat

8% World wheat production



Large pool modern varieties



Primarily grown under rainfall

Elaboration of diverse food products



Pasta



Couscous



Bulgur

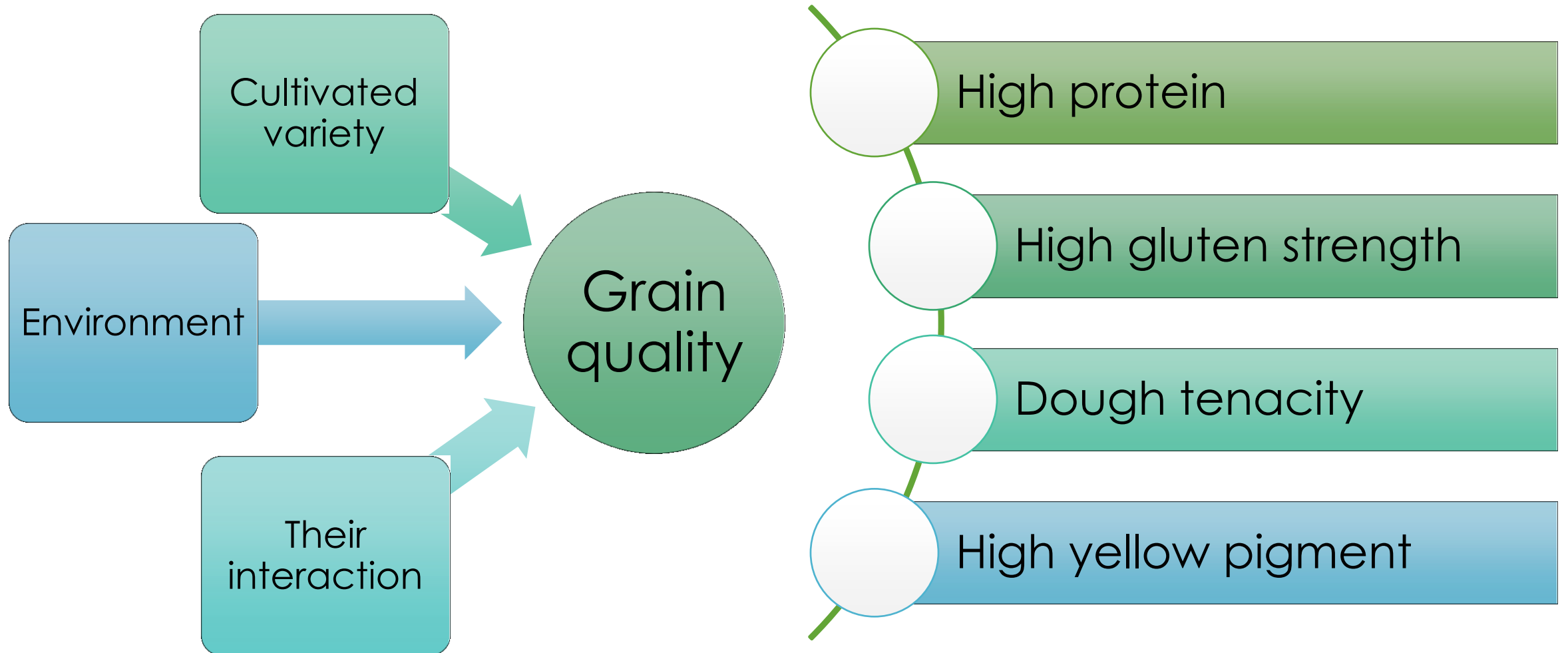


Freekeh



Various types of bread

Quality



Genetic control: dough properties

Gliadins

Glutenins

High Molecular Weight
(HMW)

- Glu-A1
- Glu-B1

Low Molecular Weight
(LMW)

- Glu-A3
- Glu-B3
- Glu-B2

Objectives

- 1) Study the effects of drought stress on grain quality.
- 2) Determine quality in varieties from breeding programs of durum wheat growing countries.
- 3) Assess the relationship between allelic variations of HMWGs and LMWGs composition with gluten properties.



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Grain quality traits of commercial durum wheat varieties and their relationships with drought stress and glutenins composition



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Materials and methods



Grain material

Country of origin

- 1** Algeria (2)
- 2** Argentina (2)
- 3** Australia (3)
- 4** Chile (1)
- 5** France (1)
- 6** India (4)
- 7** Italy (8)
- 8** Mexico (7)
- 9** Morocco (4)
- 10** Spain (6)
- 11** Tunisia (4)
- 12** USA (4)



46 Durum wheat varieties

Ciudad Obregón, Mexico (2014-2015)

Full irrigation and reduced irrigation

Physical grain parameters, rheological evaluation and allelic composition

Test performed	Equipment
Protein and moisture	NIR DA 7200 (Pertten Instruments, Sweden)
Milling	Brabender Quadrumat Senior (Brabender, Germany)
Flour yellowness	Portable Colorimeter (Konica Minolta, Japan)

Test performed	Method utilized
SDS-sedimentation	Peña et al. 1990
Mixograph	AACC 54-40.02
Alveograph	AACC 54-30.02
Bread baking	AACC 10-09.01

Test performed	Method utilized
Electrophoretic analysis	Peña et al. 2004



Results



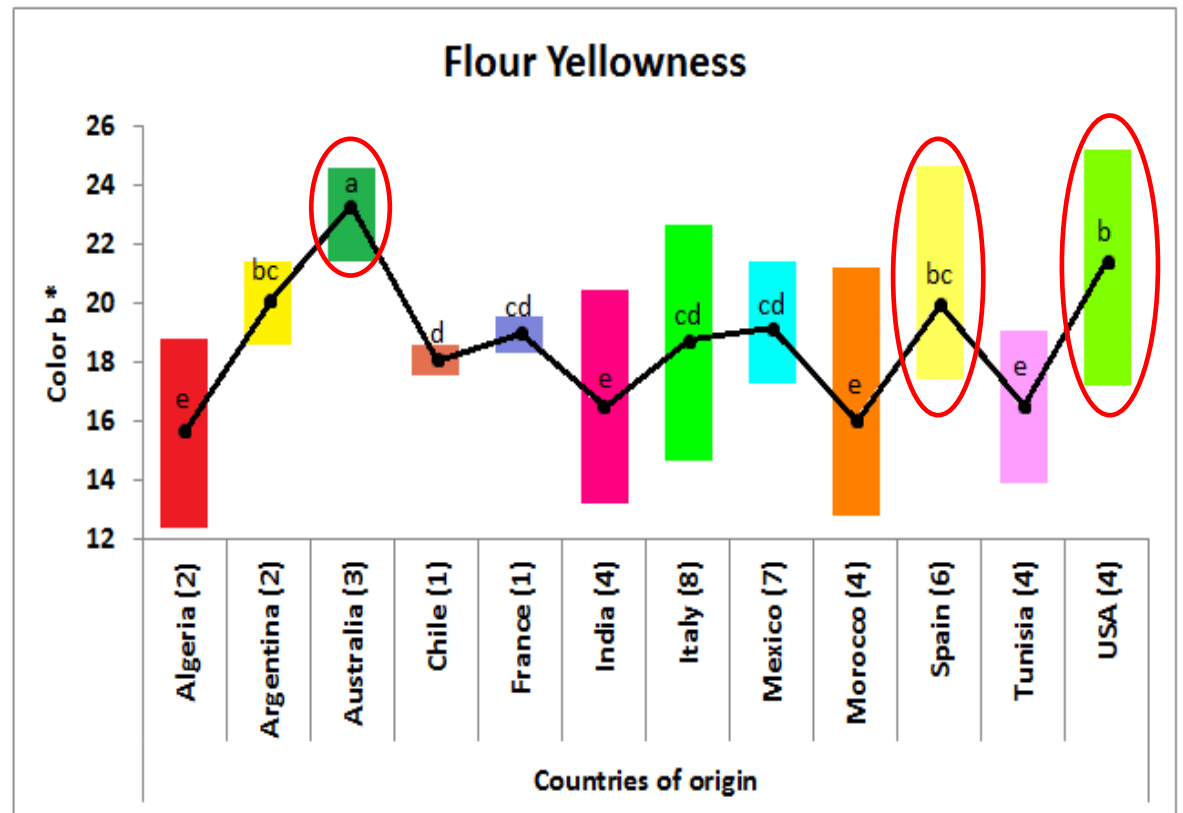
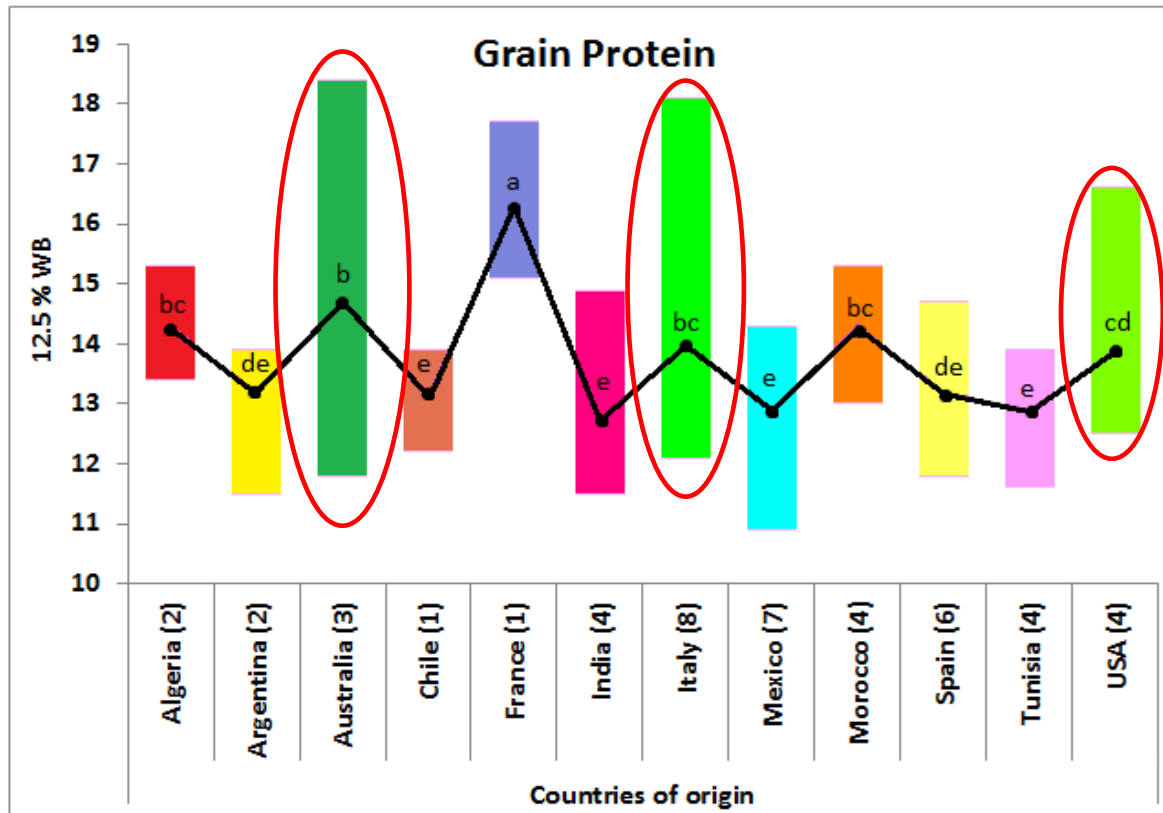
Environmental effect

Quality Test	Contribution to the Total Variance ^a	Full Irrigation	Reduced irrigation
	Environment	Mean ^b ± SD	Mean ± SD
Grain Yield (t/ha)	84.6	5.1 ± 0.7	2.6 ± 0.4
Grain Protein (12.5%WB)	23.7	13.0 ±1.1	14.2 ±1.2
Mixing Time (min)	5.8	3.3 ±1.0	2.8 ±0.9
Alveograph P / L	9.1	4.8 ±2.1	3.7 ±1.9
Loaf volume (cm ³)	5.0	623.4 ±80.1	658.7 ±75.5

^a All the values were highly significant ($p<0.001$).

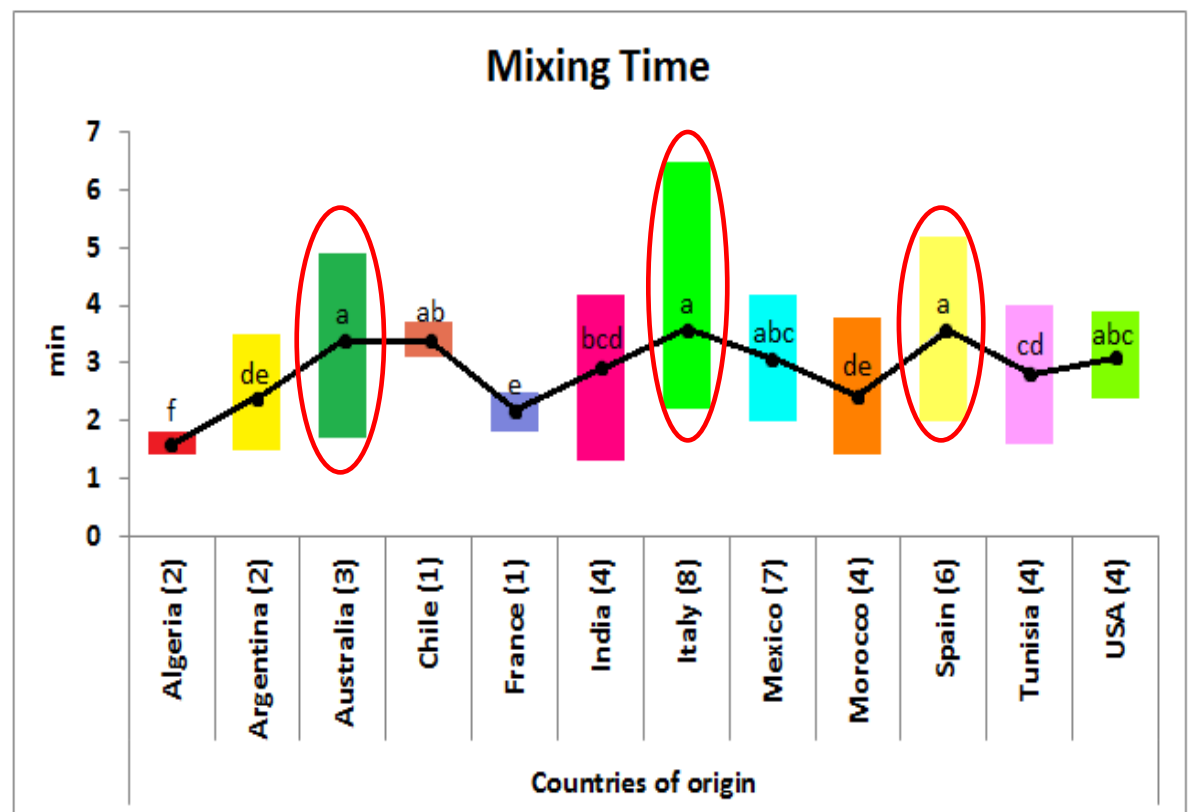
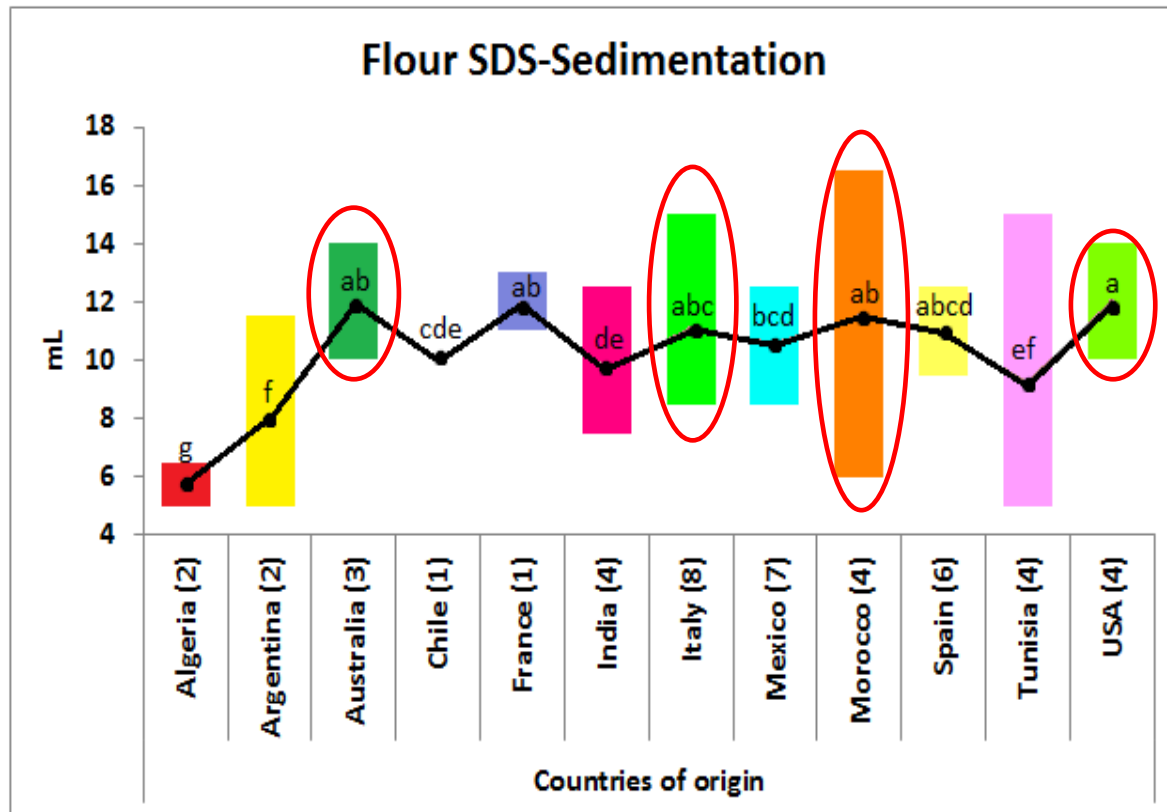
^b Each genotype in a group is represented by three samples (three replicates per field environment).

Genotype effect: Country of origin



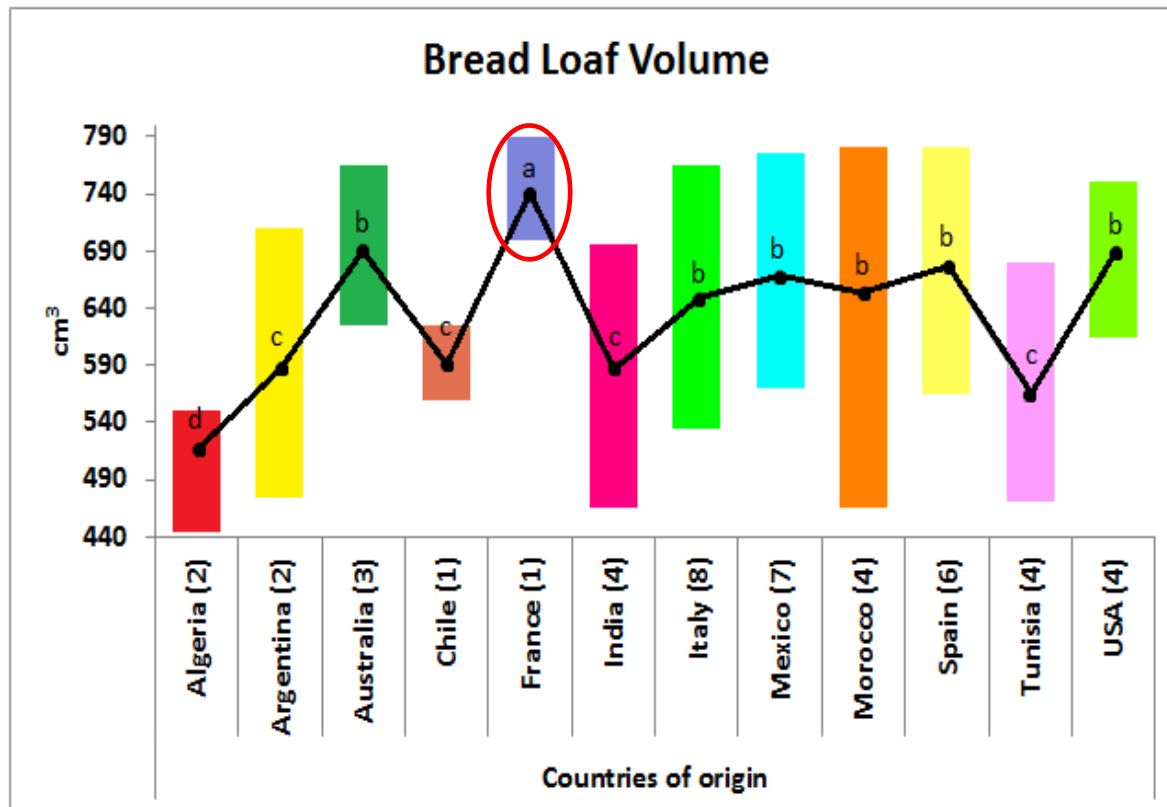
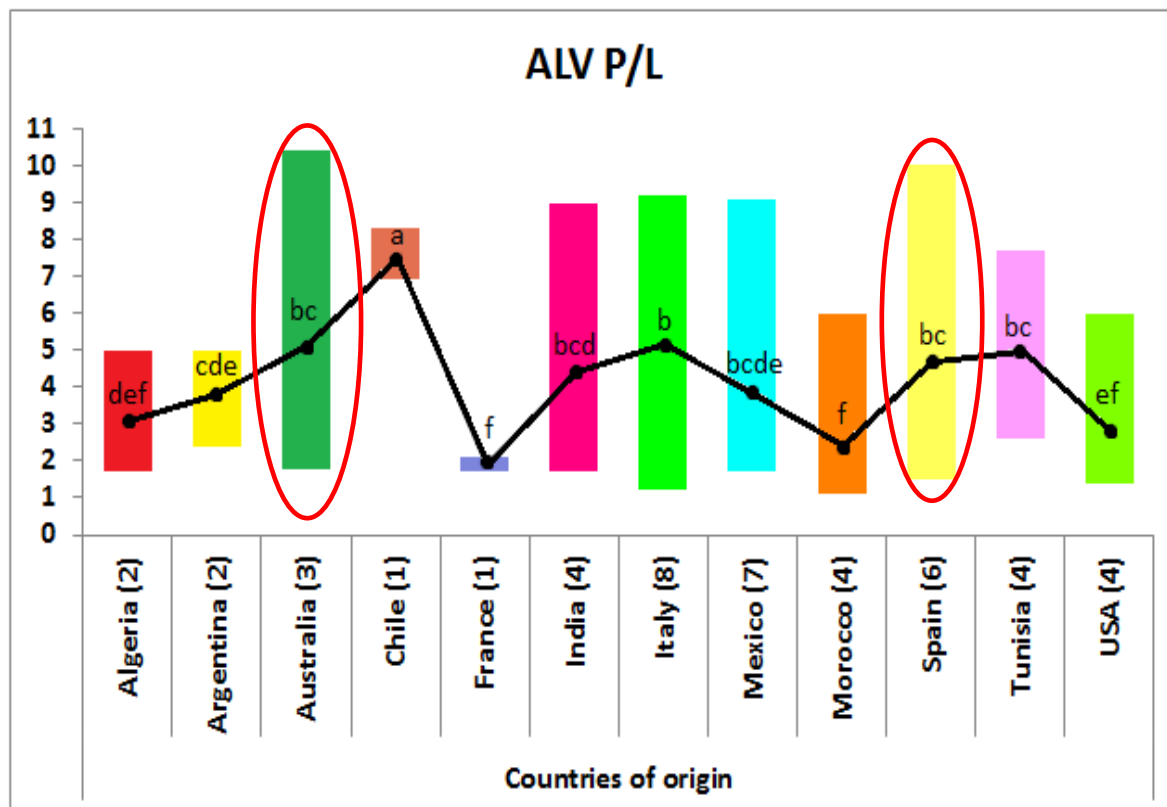
Genotypes grouped by country of origin (sample size).
The range of values (maximum and minimum) is represented by bars.
The average values are represented with a continuous dark line.
Means with the same letter within trait are not statistically significant ($P < 0.05$).

Genotype effect: Country of origin




Genotypes grouped by country of origin (sample size).
The range of values (maximum and minimum) is represented by bars.
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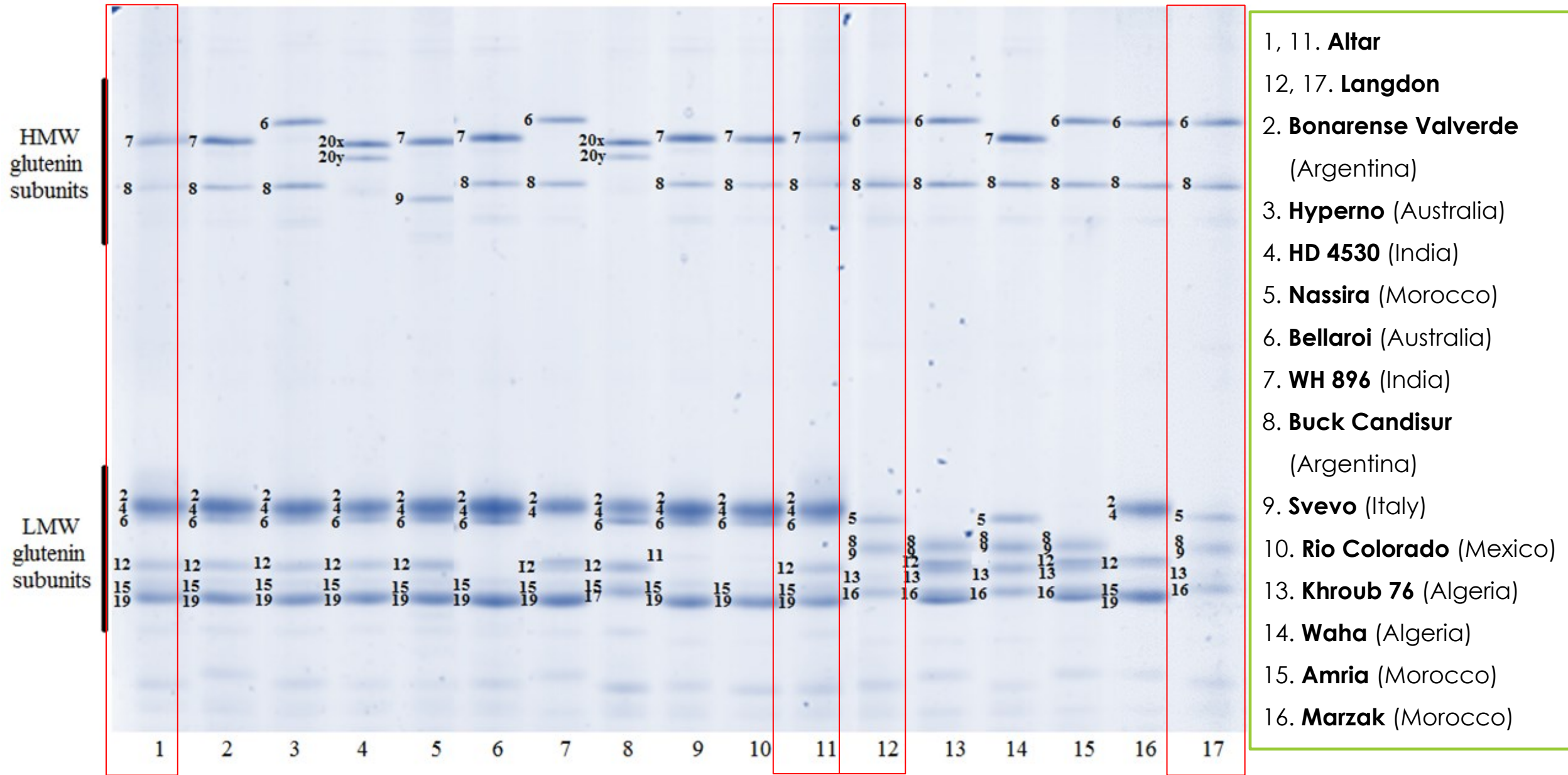
Genotype effect: Country of origin



Genotypes grouped by country of origin (sample size).
The range of values (maximum and minimum) is represented by bars.
The average values are represented with a continuous dark line.
Means with the same letter within trait are not statistically significant ($P < 0.05$).



Effects of HMW and LMW glutenin alleles on quality parameters



SDS-PAGE patterns of HMW and LMW glutenin subunits in representative durum wheats from the analyzed genotypes.

High and low
molecular weight
glutenin subunits
combinations of
each cultivar of
the study

HMW ^a		LMW ^b		%	Profile ID
Glu-B1	Glu-A3	Glu-B3	Glu-B2		
6+8 (d)	Null (h)	8+9+13+16 (b)	12 (a)	4	1
6+8 (d)	6 (a)	2+4+15+19 (a)	12 (a)	17	2
6+8 (d)	6 (a)	2+4+15+19 (a)	Null (b)	2	3
6+8 (d)	Null (h)	2+4+15+19 (a)	12 (a)	6	4
7+8 (b)	5 (b)	8+9+13+16 (b)	12 (a)	2	5
7+8 (b)	5 (b)	8+9+13+16 (b)	Null (b)	2	6
7+8 (b)	6 (a)	2+4+15+19 (a)	12 (a)	39	7
7+8 (b)	6 (a)	2+4+15+19 (a)	Null (b)	6	8
7+8 (b)	6 (a)	2+4+14+15+19 (c)	12 (a)	2	9
7+8 (b)	6+11 (d)	2+4+15+19 (a)	Null (b)	2	10
7+9 (c)	6 (a)	2+4+15+19 (a)	12 (a)	2	11
13+16 (f)	6 (a)	2+4+15+19 (a)	12 (a)	4	12
20x+20y (e)	6 (a)	2+4+15+19 (a)	12 (a)	6	13
20x+20y (e)	6 (a)	2+4+15+17 (f)	12 (a)	2	14
7 (a)	6 (a)	2+4+15+19 (a)	12 (a)	2	15

^a HMW = High Molecular Weight.

^b LMW = Low Molecular Weight.

	SDS ^a (mL)	Mixing Time (min)	Alveograph P/L	Loaf Volume (cm ³)
HMW Glu-B1				
6+8 (d)	11.4 b	3.3 b	3.3 cd	677 bc
7+8 (b)	10.1 cd	3.0 b	4.9 b	619 d
7+9 (c)	13.3 a	3.3 b	4.3 bc	682 b
13+16 (f)	10.8 bc	4.5 a	4.3 bc	732 a
20x+20y (e)	9.0 d	1.9 c	2.8 cd	604 d
7 (a)	11.0 bc	4.2 a	7.2 a	631 cd
LMW Glu-A3				
6 (a)	10.8 a	3.2 a	4.4 ab	649 ab
5 (b)	5.3 b	1.6 b	3.4 b	519 c
Null (h)	10.3 a	3.1 a	3.5 b	616 b
6+11 (d)	10.6 a	2.8 a	5.2 a	680 a
LMW Glu-B3				
2+4+15+19 (a)	11.1 a	3.3 a	4.4 b	658 a
8+9+13+16 (b)	5.8 c	1.6 b	2.9 c	520 c
2+4+14+15+19 (c)	9.0 b	2.9 a	5.9 a	587 b
2+4+15+17 (f)	5.7 c	1.6 b	3.3 bc	496 c
LMW Glu-B2				
12	10.6 a	3.1 a	4.1 a	642 a
null	10.1 a	2.7 a	5.3 a	634 a

Means with the same letter within trait and locus are not statistically significant ($P<0.05$).

^a SDS = Flour SDS-Sedimentation.

	SDS ^a (mL)	Mixing Time (min)	Alveograph P/L	Loaf Volume (cm ³)
HMW Glu-B1				
6+8 (d)	11.4 b	3.3 b	3.3 cd	677 bc
7+8 (b)	10.1 cd	3.0 b	4.9 b	619 d
7+9 (c)	13.3 a	3.3 b	4.3 bc	682 b
13+16 (f)	10.8 bc	4.5 a	4.3 bc	732 a
20x+20y (e)	9.0 d	1.9 c	2.8 cd	604 d
7 (a)	11.0 bc	4.2 a	7.2 a	631 cd
LMW Glu-A3				
6 (a)	10.8 a	3.2 a	4.4 ab	649 ab
5 (b)	5.3 b	1.6 b	3.4 b	519 c
Null (h)	10.3 a	3.1 a	3.5 b	616 b
6+11 (d)	10.6 a	2.8 a	5.2 a	680 a
LMW Glu-B3				
2+4+15+19 (a)	11.1 a	3.3 a	4.4 b	658 a
8+9+13+16 (b)	5.8 c	1.6 b	2.9 c	520 c
2+4+14+15+19 (c)	9.0 b	2.9 a	5.9 a	587 b
2+4+15+17 (f)	5.7 c	1.6 b	3.3 bc	496 c
LMW Glu-B2				
12	10.6 a	3.1 a	4.1 a	642 a
null	10.1 a	2.7 a	5.3 a	634 a

Means with the same letter within trait and locus are not statistically significant ($P<0.05$).

^a SDS = Flour SDS-Sedimentation.

Conclusion

Drought stress

Increase protein content

Qualitative changes



Varieties

Australia

Italy

USA



Genetic control

Positive/negative effects of some alleles were confirmed

Take home message

Genetic factors

Determine
qualitative
composition

Growing conditions

Modify
quantitative
composition

Varieties

The study may
not necessarily
reflect their full
potential

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