Instituto Nacional de Investigación Agropecuaria

URUGUAY

Influence of genotype and environment on wheat protein fractions and their relationship with dough rheological properties

4th ICC Latin American Cereals Conference

13th International Gluten Workshop

11-17 March 2018

Mexico City, Mexico

LACC IGW

Andrea Balzani

Daniel Vázquez

INIA URUGUAY

Introduction

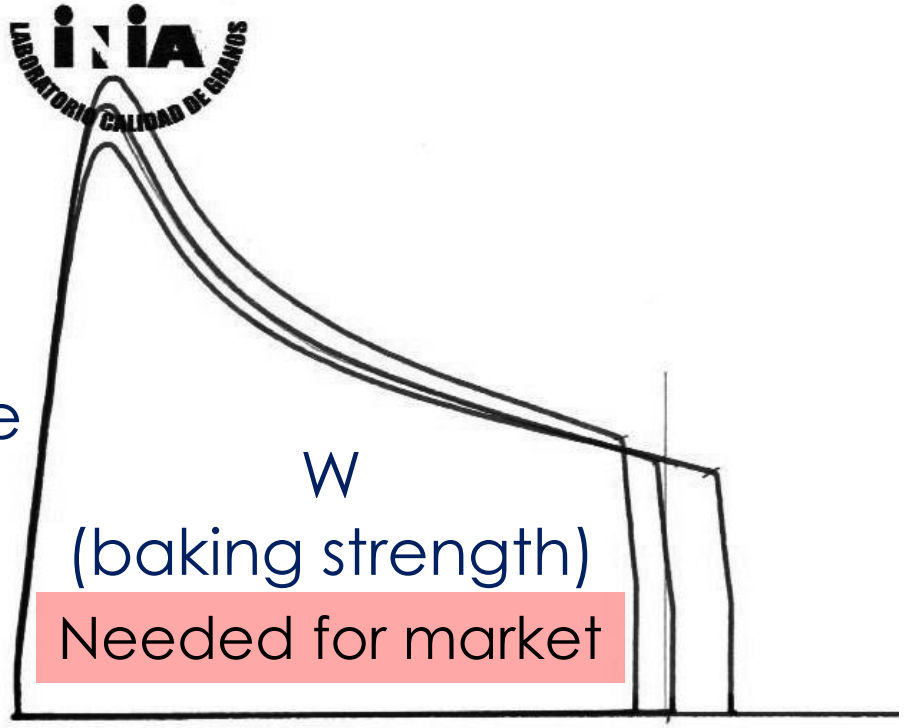
- Wheat quality is needed to compete internationally
- What is quality? (hard red spring, for bread)
  - Physical properties
  - No germination
  - Protein amount
  - Rheological properties

- The most relevant problem
- The system is lack in N

Alveogram

P
(máximum resistance to extension)

Needed for bread shape
Vázquez, 2005



Key for bread volume
Vázquez & Watts, 2004

Introduction

- Wheat quality is needed to compete internationally
- What is quality?
  - Physical properties
  - No germination
  - Protein amount
  - Rheological properties, i.e., Alveograph parameters
- Gluten (protein) composition define rheological properties
- SE-HPLC proved to be useful to study these proteins

Introduction

- Environmental effect
  - = any effect that is not genetic
  - We can divide in:
    - Manageable: i.e.: geographical location, N in soil
    - Not manageable: weather
  - We focused on the most manageable effect:
    N availability

Objectives

- To contribute to understand the relationship of rheological properties and protein fractions

- To understand the effect of G, E & GxE on these components

Materials and methods

Genotypes

n=16

Name	Breeder	Country
ACA 902	ACA	Argentina
Arex	Biotrigo Genetica	Brasil
Baguette 501	Nidera Semillas S.A.	Argentina
Biointa 1006	INTA	Argentina
Fuste	Biotrigo Genetica	Brasil
Génesis 2375	INIA	Uruguay
Génesis 6.81	INIA	Uruguay
Klein Nutria	Criadero Klein S.A.	Argentina
LE 2331 INIA Don Alberto	INIA	Uruguay
LE 2332 INIA Madrugador	INIA	Uruguay
LE 2333 INIA Carpintero	INIA	Uruguay
LE 2409	INIA	Uruguay
SYN 200	Syngenta Crop Protection	Argentina
SYN 300	Syngenta Crop Protection	Argentina
TEC 10	Fundacep CCGL	Brasil
TEC 12	Fundacep CCGL	Brasil

Environments

- 2 locations, 2 reps
- Differencial N treatments:
  - La Estanzuela: commercially used fertilization
  - Young: +N @ Z50 & Z60

Traditional analysis

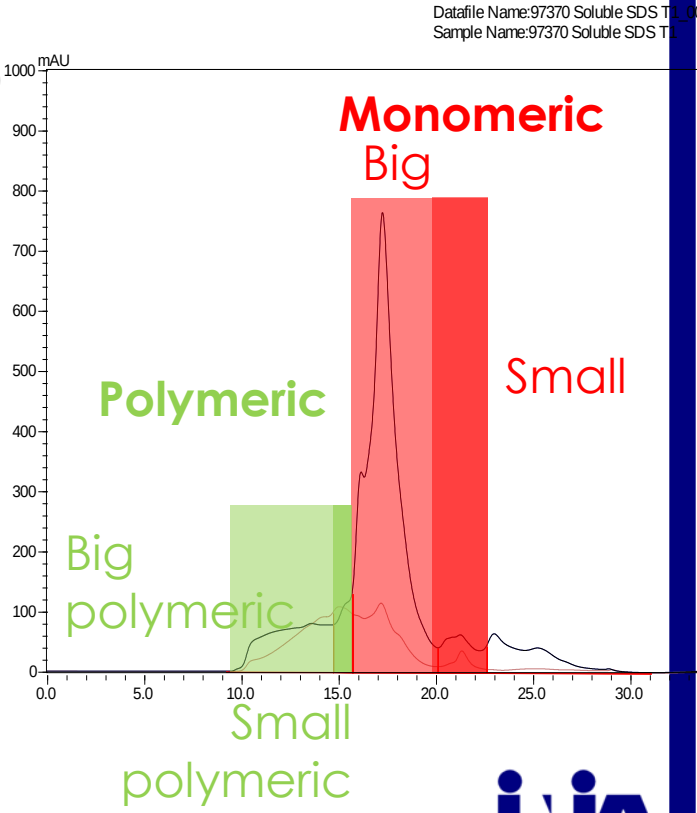
- Protein (NIR)
- Alveogram AACC 54-30

SE-HPLC

- 2-step extraction (Gupta et al., 1993)
  - Step 1:
    - $Flour_{16.6mg}$+$phosphate\ buffer_{0.1M}$, ph 6.9–$SDS\ 2\%_{1.4mL}$
    - Vortexed, stirred, centrifugated, heated → "soluble fraction"
  - Step 2:
    - $Pellet\ resuspended\ in\ the\ same\ buffer_{1.4mL}$
    - Sonicated
    - Centrifugated, heated → "unextractable fraction"

SE-HPLC

- 2-step extraction (Gupta et al., 1993)
- Shimadzu LC-20
- Column: BioSep SEC-s4000$_{Phenomenex}$
- Eluant: extraction buffer$_{0.2mL/min}$
- Detector: UV 210nm



Parameters (quantitative)

- TOTT = total proteins = total area of both extracts
- TOTE = total extractable proteins =
  total area of first extract
- TOTU = total **un**extractable proteins =
  total area of second extract
- PP = polymeric proteins =
  the first two regions of both extracts
- MP = monomeric proteins =
  the last two regions of both extracts

Parameters (qualitative)

- PP/MP = polymeric:monomeric proteins ratio
- UPP = unextractable proteins percentage =
  % of unextractable polymeric proteins
  out of total polymeric proteins

Statistical analysis

- ANOVA and PCA using InfoStat package
  (Di Rienzo et al., 2016)

RESULTS & DISCUSSION

Correlations (of selected parameters)

	Protein content	ALVEOGRAPH W	ALVEOGRAPH P	ALVEOGRAPH L
TOTT	0.930***	0.700***	-0.330	0.800***
TOTE	0.910***	0.590***	-0.450***	0.810***
TOTU	0.720***	0.800***	0.080	0.530***
PP	0.730***	0.800***	0.020	0.590***
MP	0.880***	0.560***	-0.430***	0.770***
PP/MP	-0.410***	0.020	0.550***	-0.410***
UPP	-0.170	0.140	0.420***	-0.130

***Significant at P<0.001

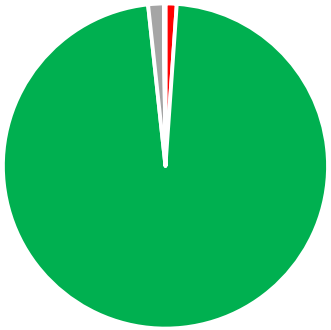
ANOVA

P-values of selected parameters

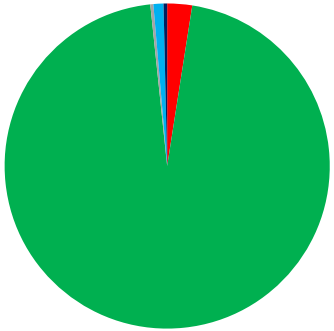
		Protein	Alveograma			HPLC			
	DF	content	W	P	L	TOTE	TOTU	UPP	PP/MP
G	15	<0,0001	<0,0001	<0,0001	0,0001	<0,0001	<0,0001	<0,0001	<0,0001
E	1	<0,0001	<0,0001	0,0003	<0,0001	<0,0001	<0,0001	0,2428	<0,0001
Rep	2	0,0004	0,4369	0,2197	0,7310	0,3072	0,7136	0,0147	<0,0001
GxE	15	0,0006	0,0084	0,0005	0,2107	0,0316	0,0018	<0,0001	0,1200
Error	30								

Components of variance

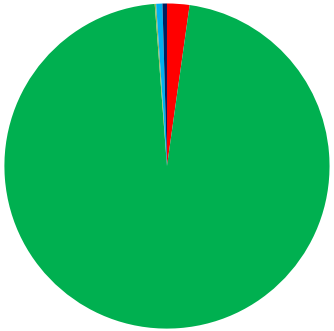
Protein content



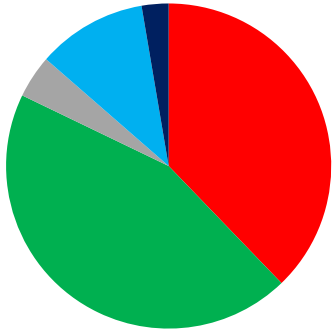
Alveogram W



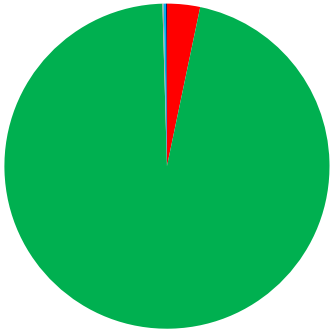
Alveogram L



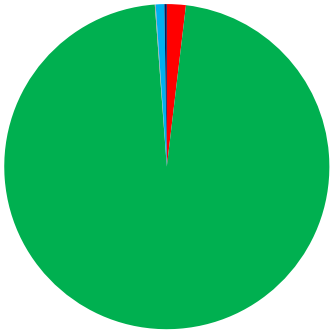
Alveogram P



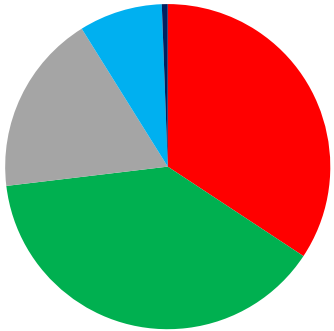
TOTE



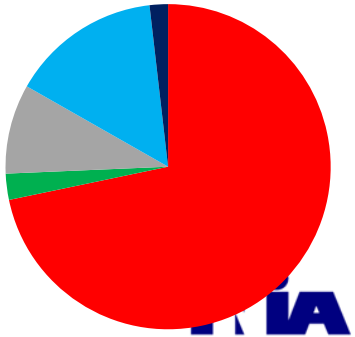
TOTU

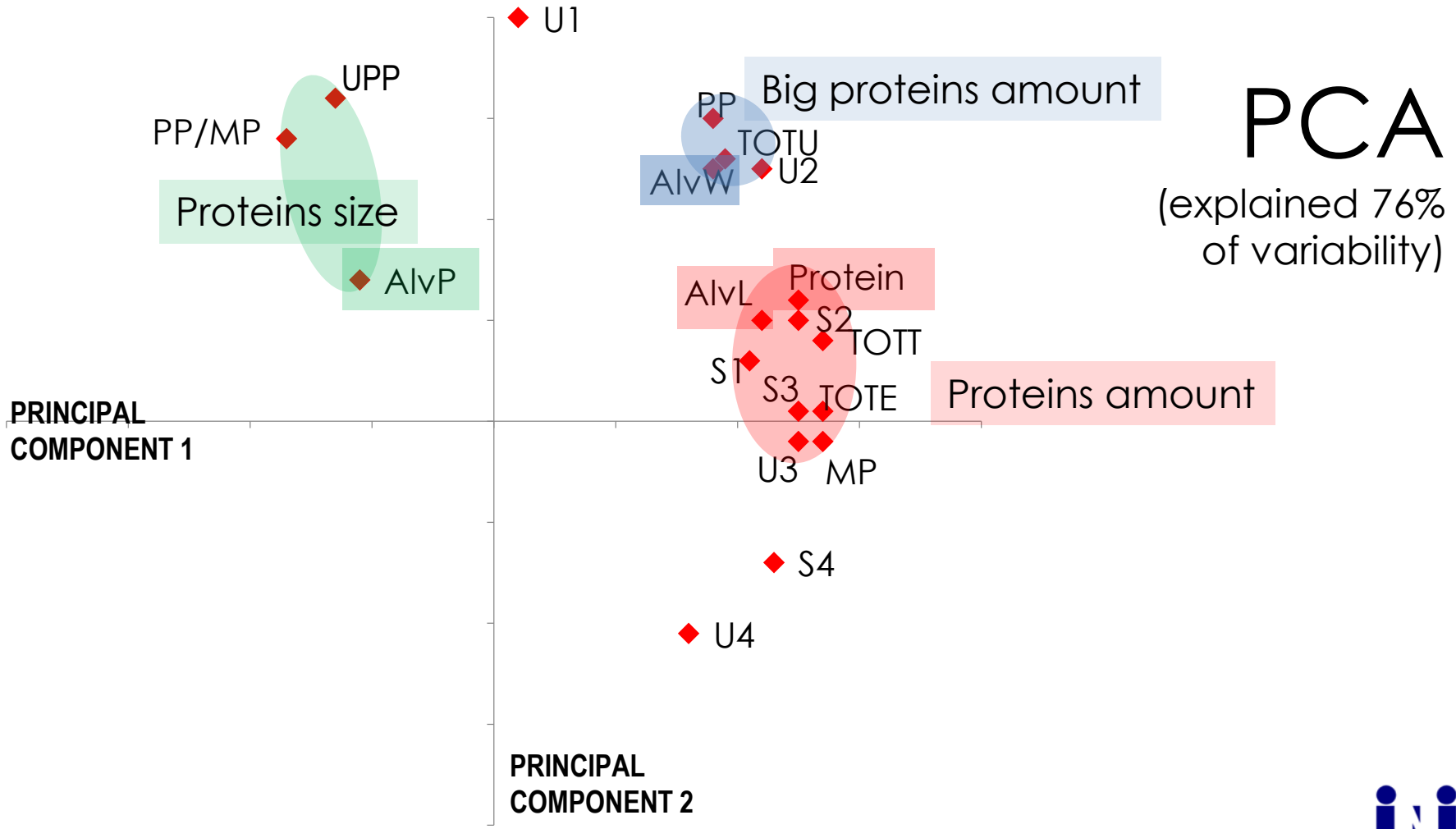


PP/MP



UPP





PCA

(explained 76% of variability)

Conclusions

- Balance among HPLC parameters is needed:
  - Total proteins to get extensibility
  - Amount of big proteins to get baking strength
  - Big polimers to get resistance to extensión
- Balance between G and E is needed:
  - Environment to reach proteins quantity
  - Genotype to reach proteins quality

Aknlowdgments

- Funded by FSA_1_2013_1_12494

- Field trials conducted by Martin Quincke

- Lab work supported by José Hernández, Daniela Ramallo, María E.García & Patricia González

MUCHAS GRACIAS

dvazquez@inia.org.uy