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INTEGRATED APPROACH TO UNDERSTAND THE FUNCTIONING OF WHEAT QUALITY COMPONENTS AND THEIR INTERACTION WITH ENVIRONMENTS

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UR-Valorization of Tunisian Natural Ressources and Food Heritage through Innovation

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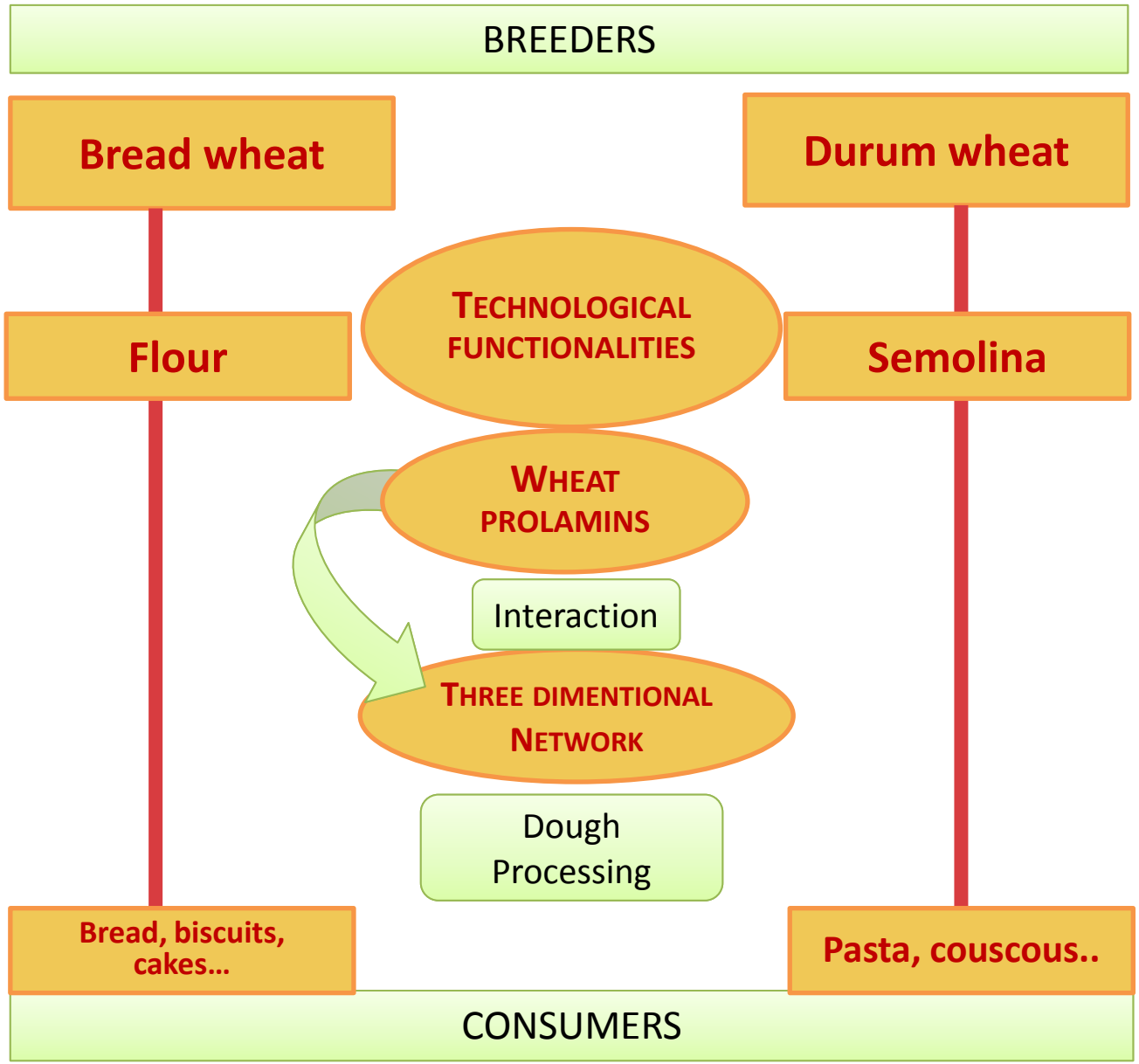
INTRODUCTION

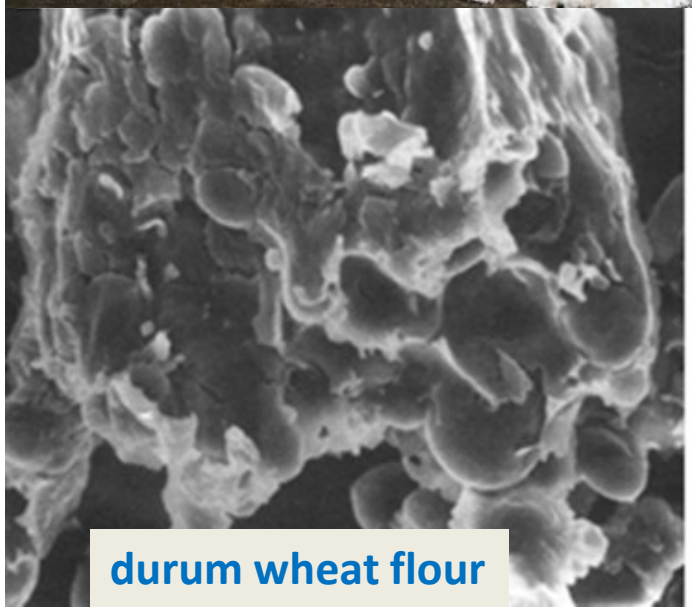
CEREAL FOOD CHAIN



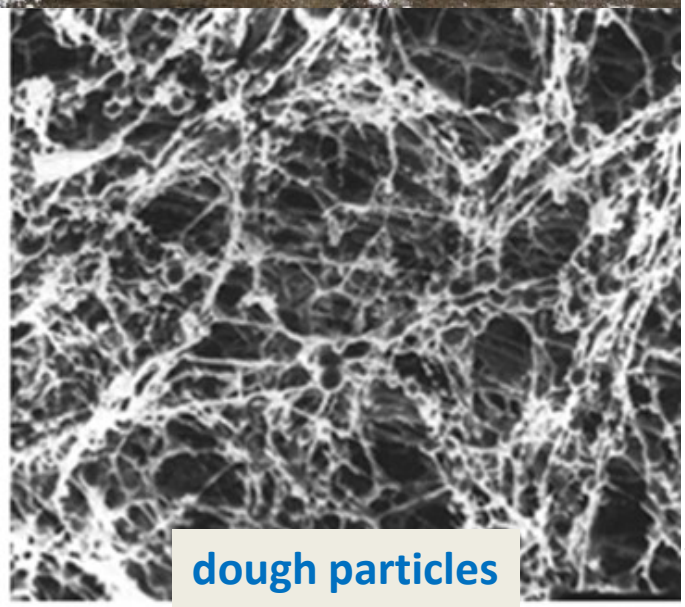
INTRODUCTION

Scanning electron micrographs

(Hoseney and Rogers 1990)



durum wheat flour

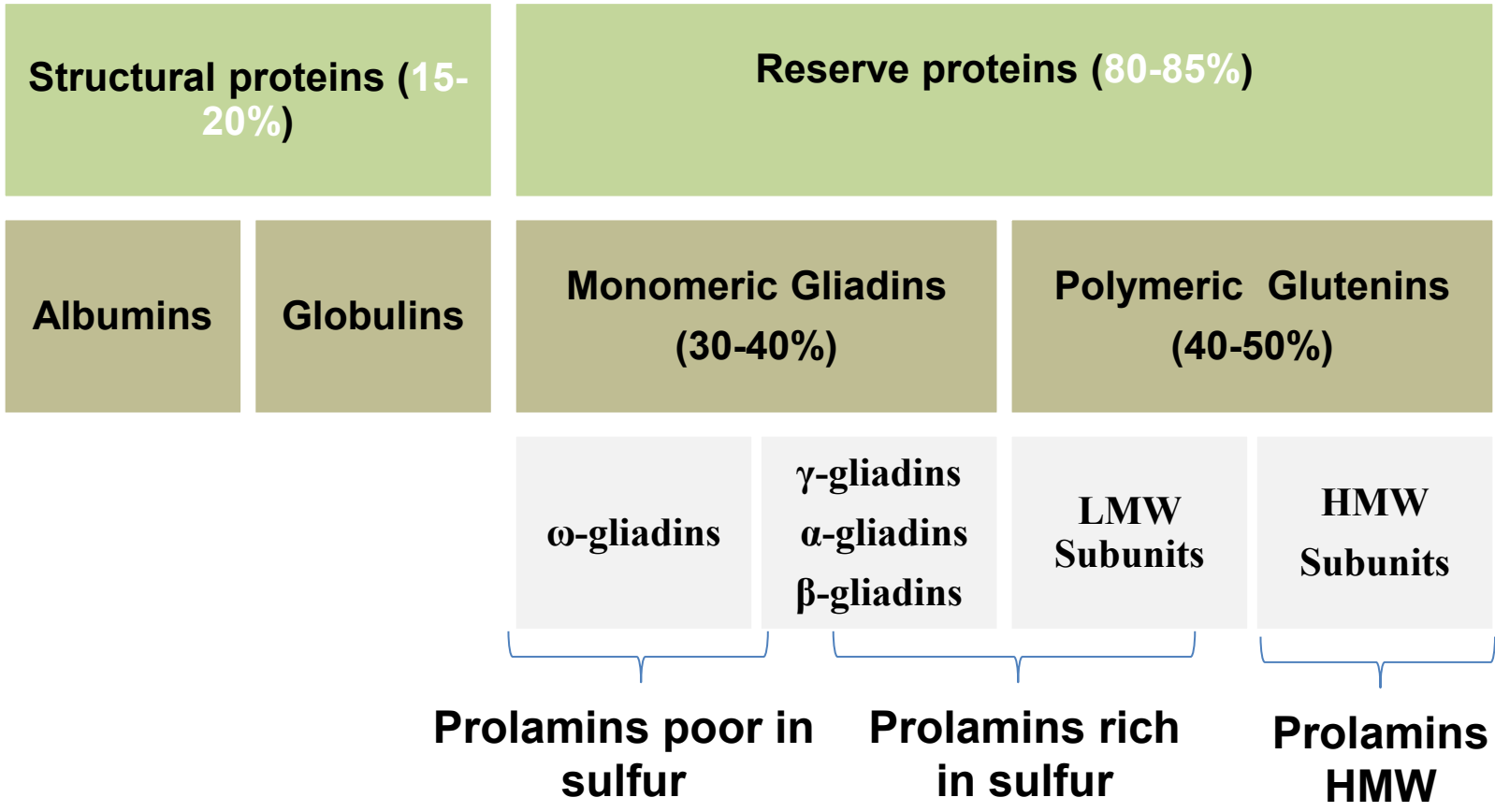


dough particles

Molecular Weight Distribution (MWD) of Wheat Storage Proteins

Wheat Proteins

Classification and Polymorphism of Wheat Grain Proteins

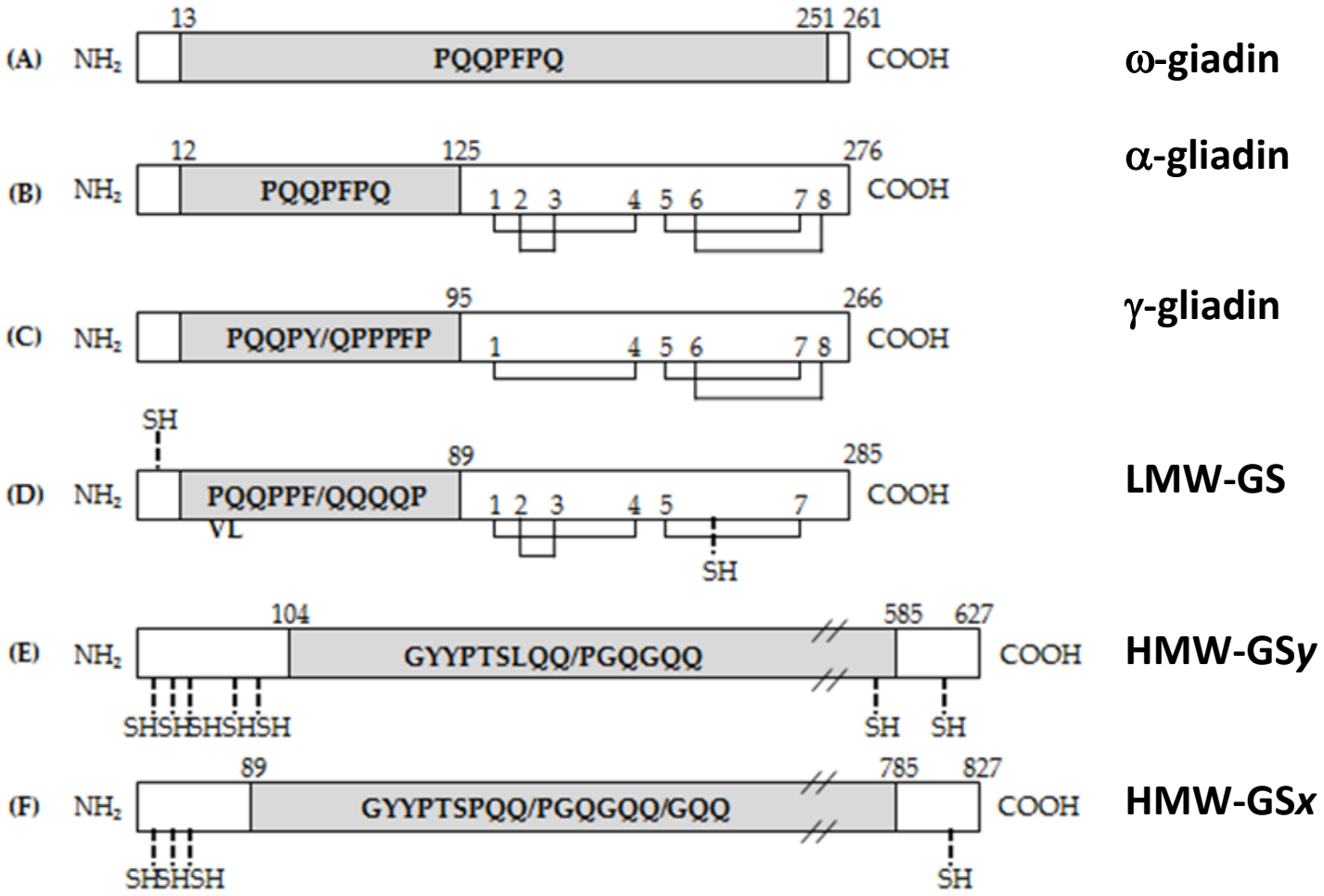


(Goesaert et al., 2005 ; Feillet., 2000)

Molecular Weight Distribution (MWD) of Wheat Storage Proteins

Classification and Polymorphism of Wheat Grain Proteins

Schematic structures of typical primary structures of wheat proteins



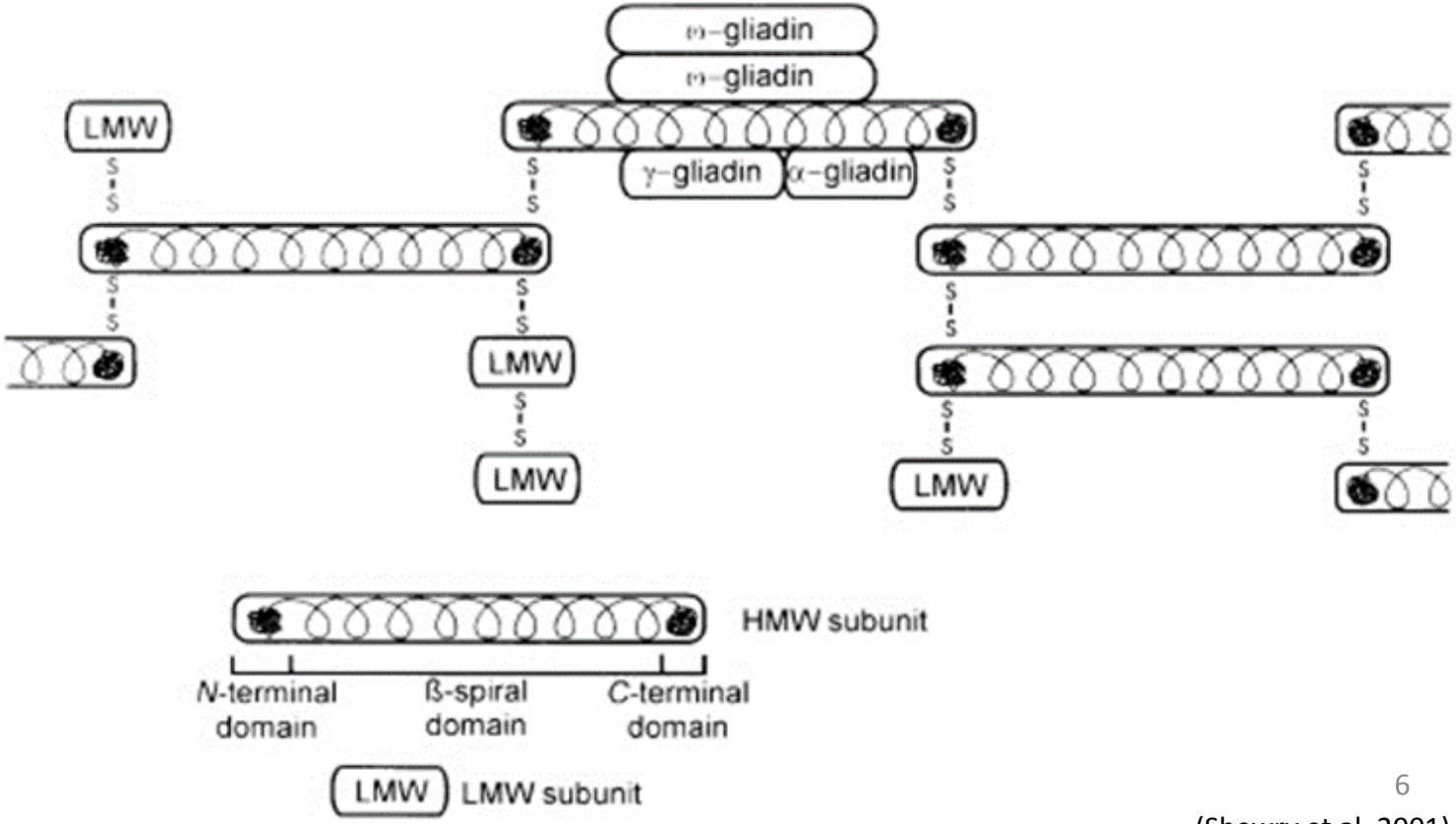
(Shewry et al., 2002)

Molecular Weight Distribution (MWD) of Wheat Storage Proteins

Gliadin to Glutenin Ratio



A structural model for wheat gluten



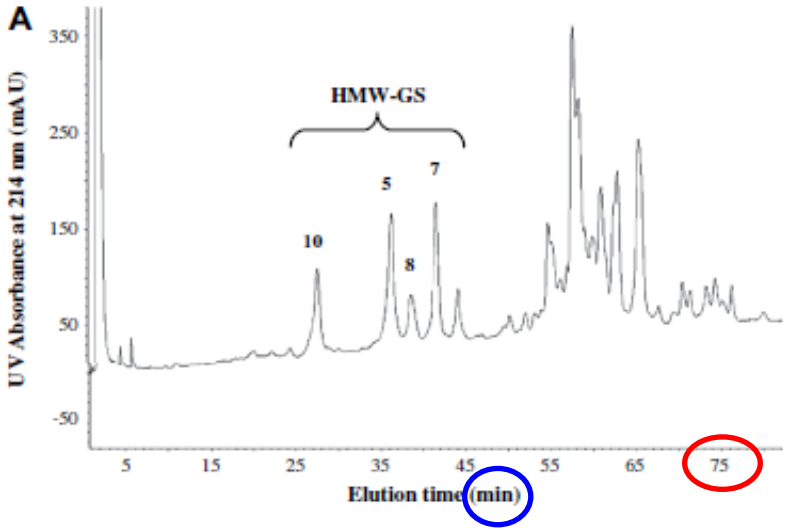
(Shewry et al. 2001)

Molecular Weight Distribution (MWD) of Wheat Storage Proteins

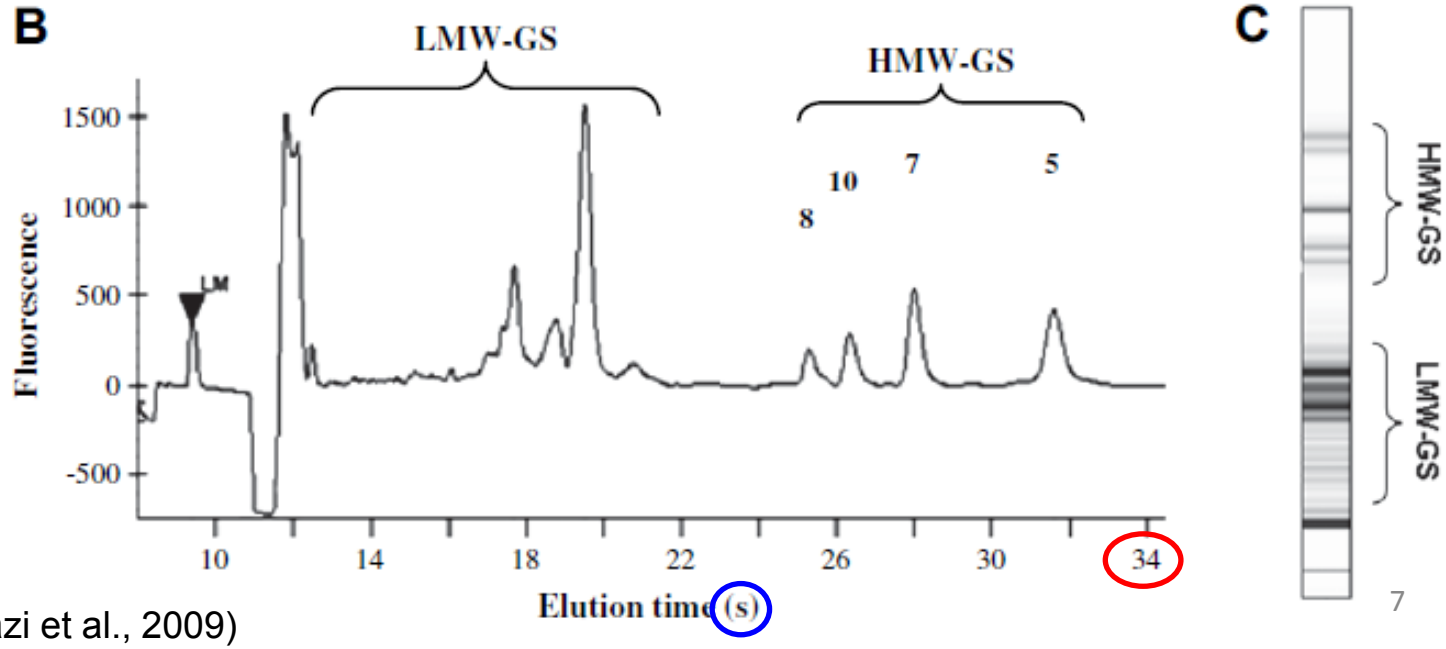
HMW-GS identification and quantification

Distribution of Glutenin subunits

RP-HPLC



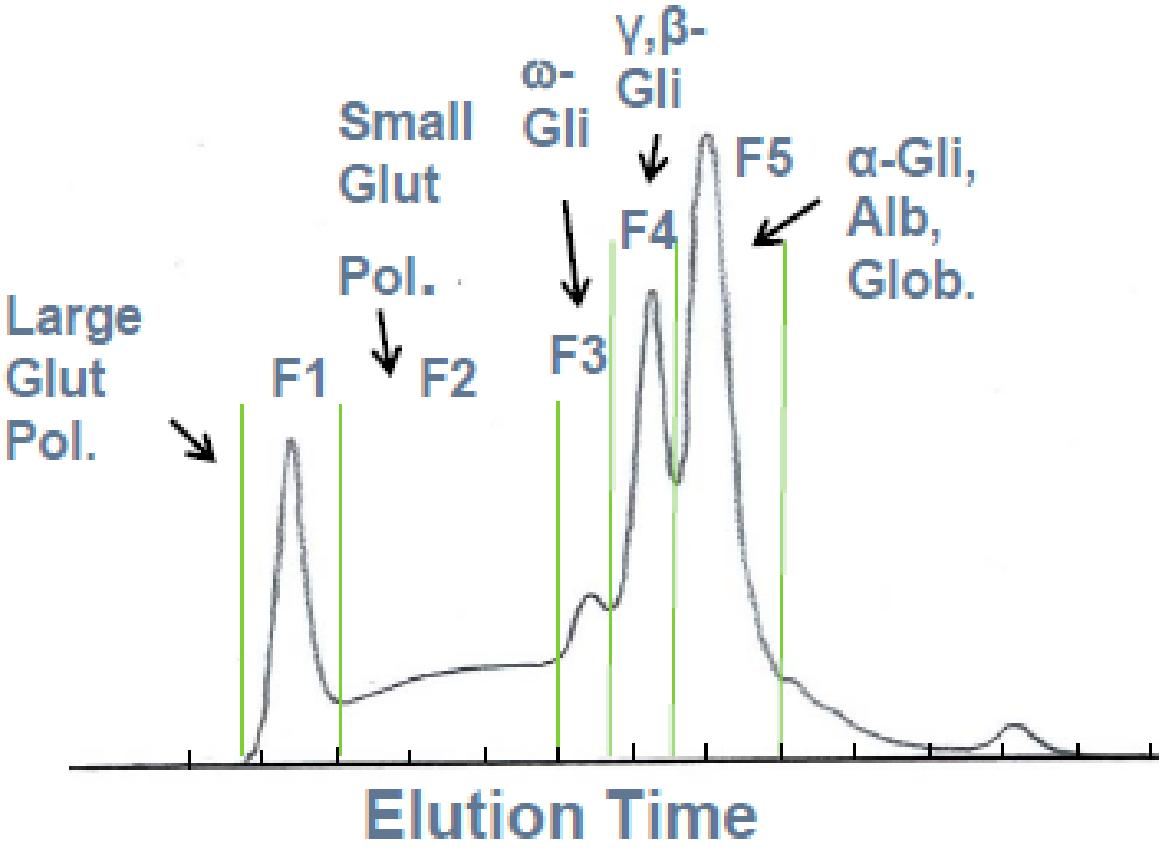
Lab-On-Chip



(Rhazi et al., 2009)

Molecular Weight Distribution (MWD) of Wheat Storage Proteins

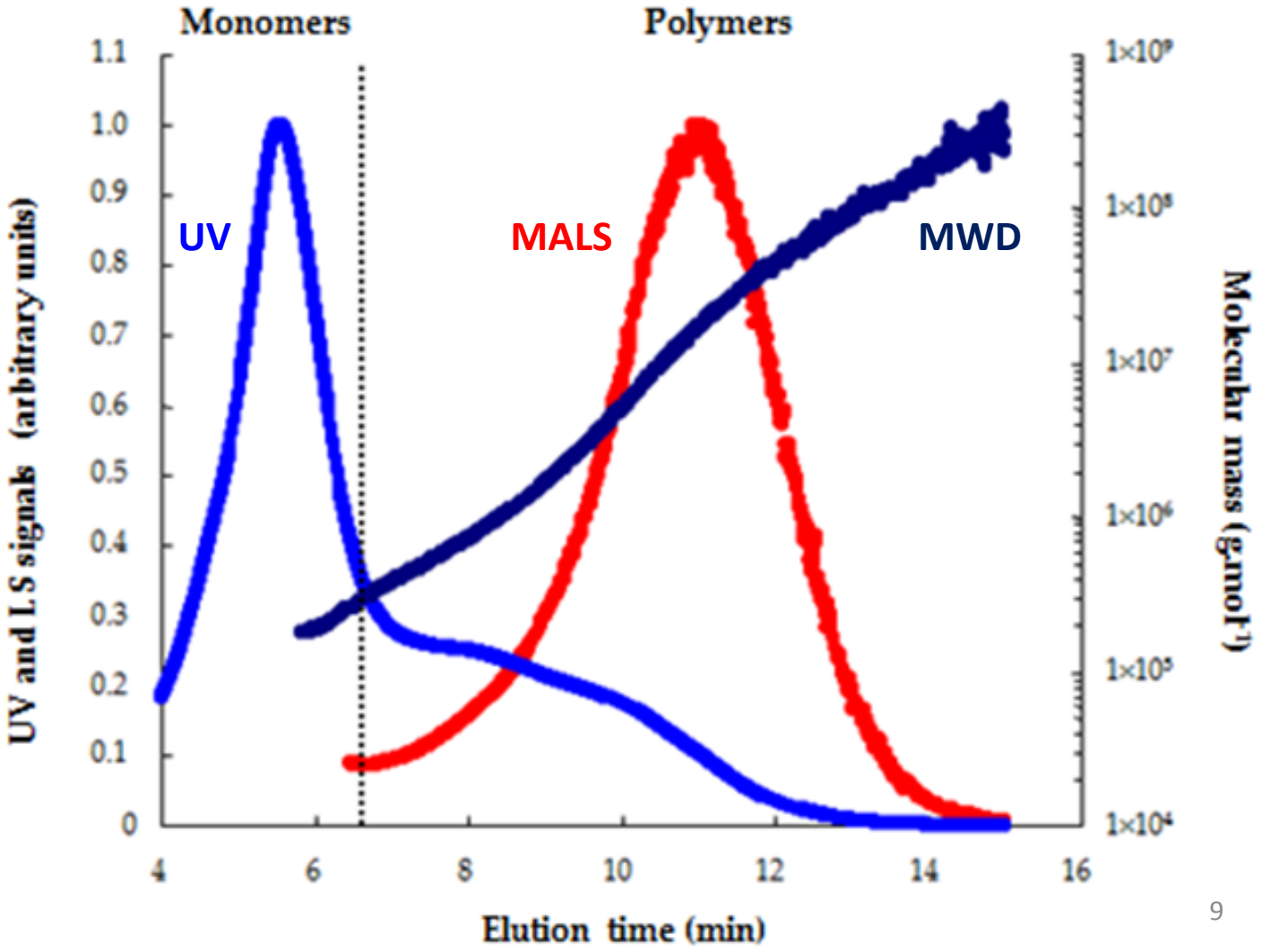
Size Distribution of Polymeric Proteins



SEC-HPLC

Molecular Weight Distribution (MWD) of Wheat Storage Proteins

Size Distribution of Polymeric Proteins



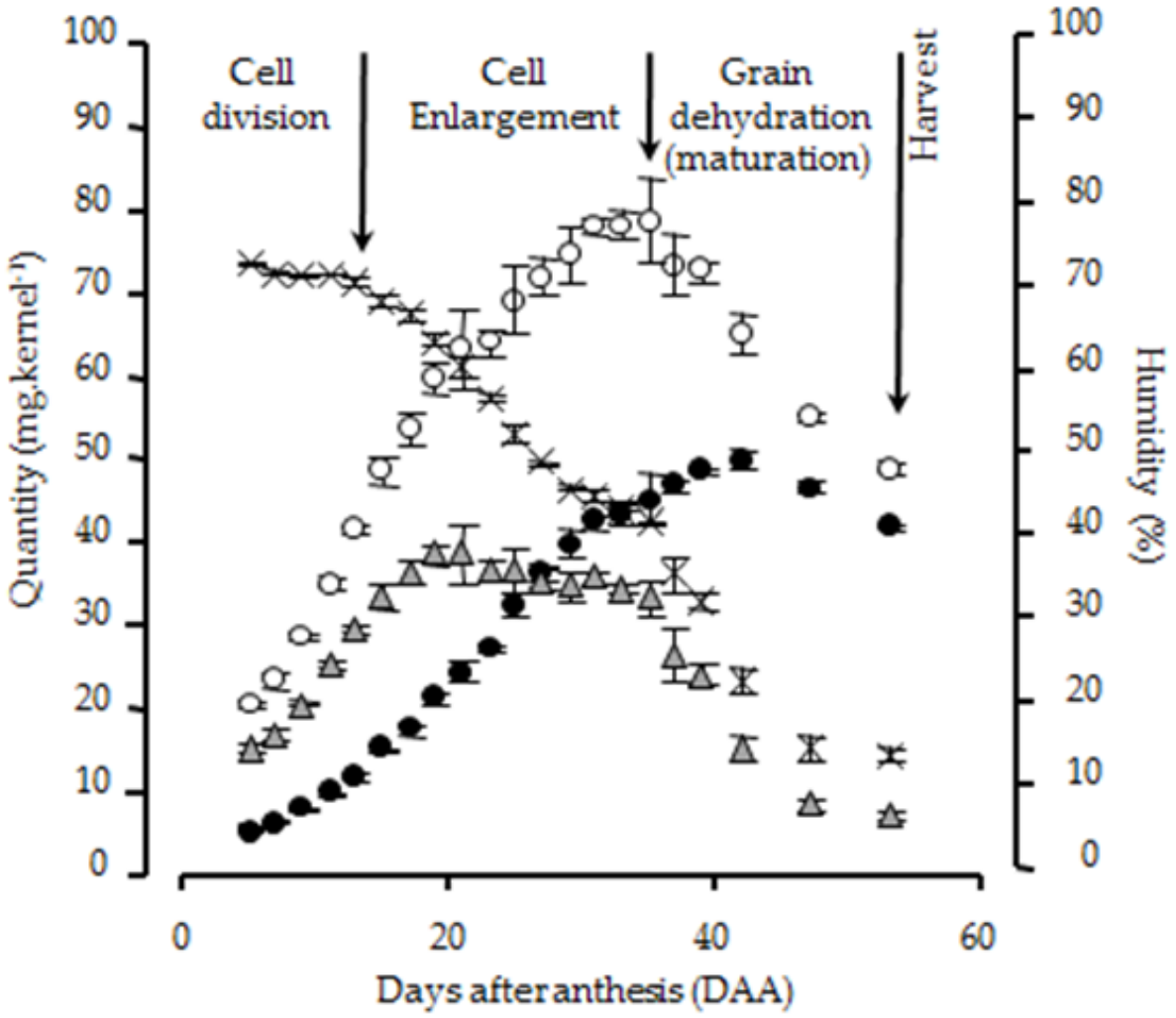
Asymmetrical flow field-flow fractionation (A4F)

Accumulation of Prolamins in Developing Wheat Grains

Endosperm development

Per kernel
(●) dry matter
(O) fresh matter
(▲) water quantity
(X) grain humidity

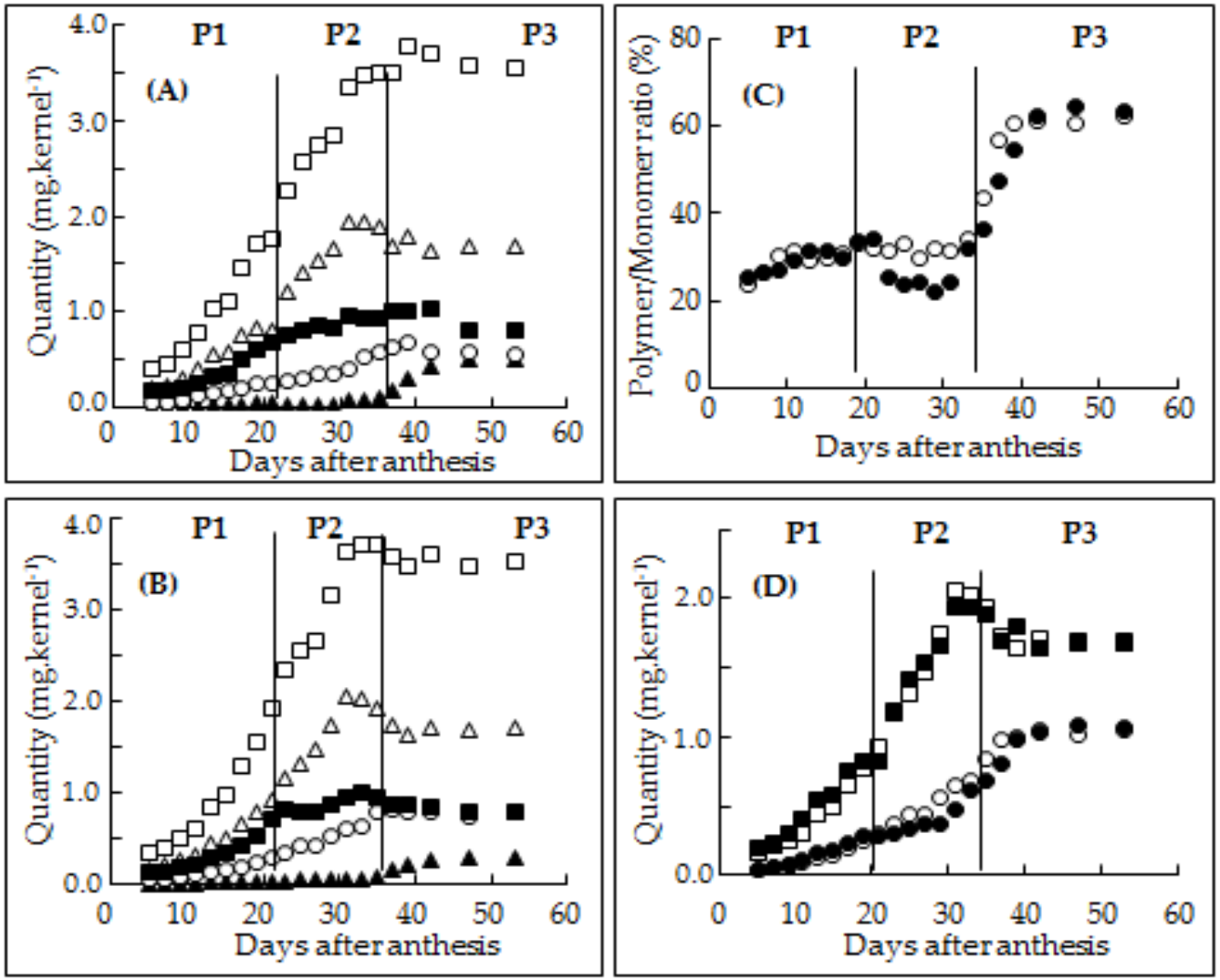
Grain filling period for a common wheat cultivar (Soissons).



Accumulation of Prolamins in Developing Wheat Grains

Fig A & B

(▲) SDS-insoluble polymers
(O) SDS-soluble polymers;
(■) albumins and globulins;
(Δ) monomers and;
(●) total proteins



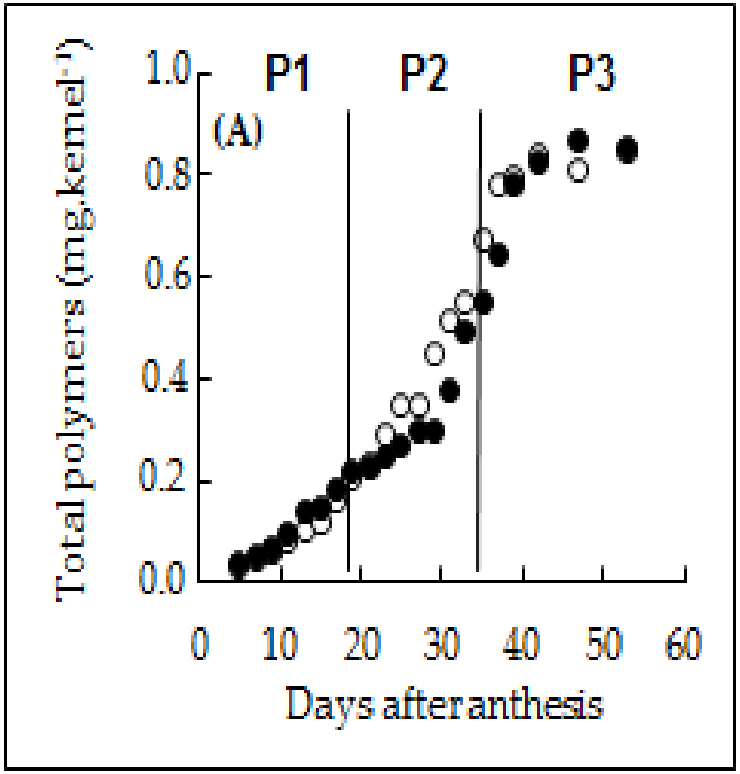
(A) Soissons and **(B)** Thésée

(C): (O,●) total polymers of Thésée and Soissons respectively
(D):(■,□) Monomers of Thésée and Soissons respectively

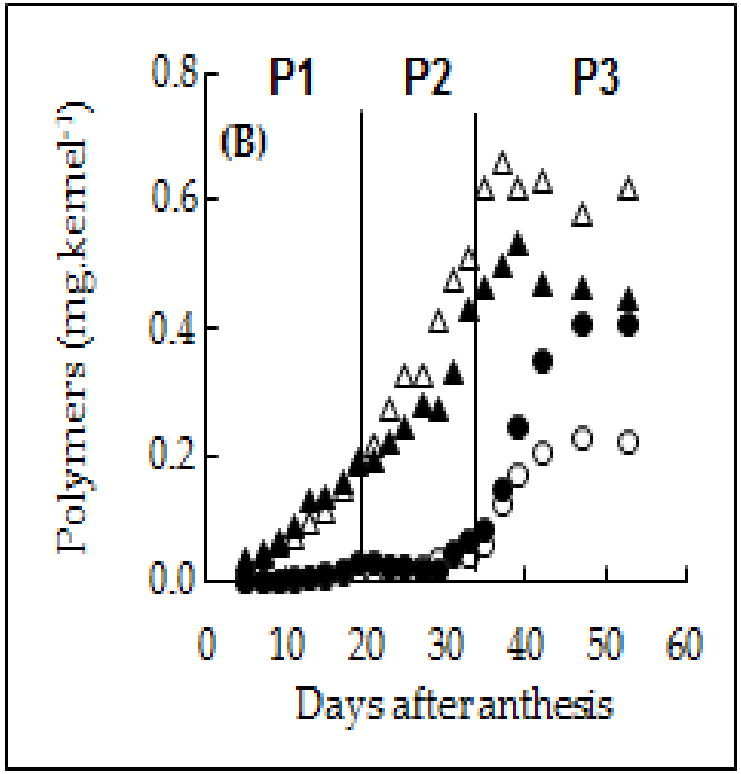
Accumulation of Prolamins in Developing Wheat Grains

Unextractable Polymeric Protein (UPP) accumulation

Accumulation of total polymers, SDS-soluble and SDS-insoluble polymers



(●) Soissons and, (O) Thésée.

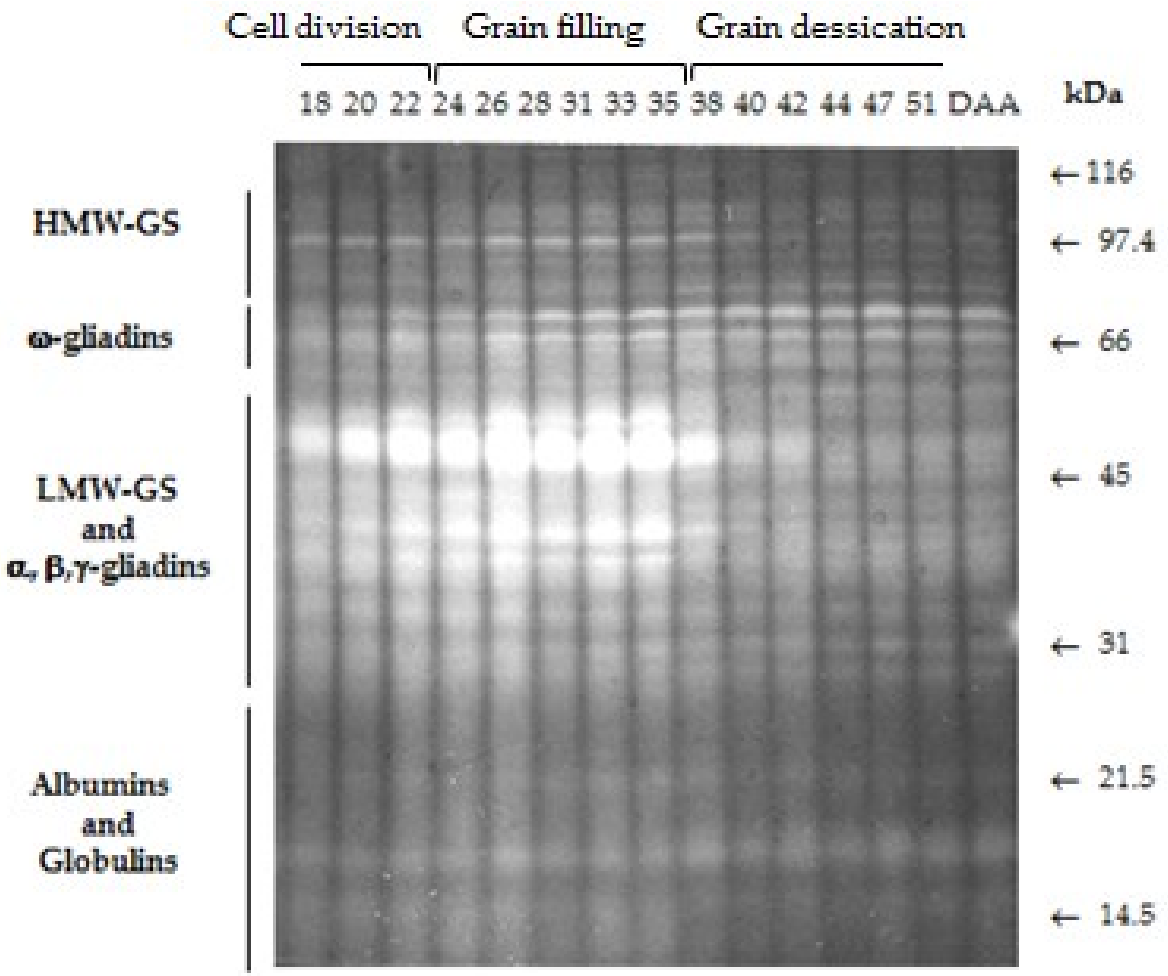


Open symbols = Thésée,
closed symbols = Soissons.
(▲, Δ)SDS-soluble polymers
(●,O) SDS-insoluble polymers.

P1 cell division; P2 cell enlargement and P3 grain desiccation and maturation

Accumulation of Prolamins in Developing Wheat Grains

Unextractable Polymeric Protein (UPP) accumulation



Change in sulfhydryl status of wheat proteins during grain development and maturation. MBBr-derivatized

Impacts of Environmental Factors on Glutenin subunits

Changes in HMW/LMW HMWy/HMWx

Variation of the HMW-GS relatives percentages,
the HMW-GS/LMW-GS
And
HMW-Gsy/ HMW-Gsy ratios

Source	DF	HMW-GSy to HMW-GSx	HMW-GS to LMW-GS
E	3	0.0159**	312.7616**
r(E)	8	0.0041	11.6443
G	7	0.7660**	483.3586**
F	3	0.0184**	44.0489**
ExG	21	0.0020**	67.5617**
GxF	21	0.0013**	44.9707**
ExF	9	0.0025**	79.5278**
ExGxF	63	0.0012**	35.6428**
r (ExGxF)	248	0.0006	3.9836
CV(%)		8.4	9.7

8 durum wheat genotypes
grown in 2 different environments
using 4 fertilizer treatments
during 2 cropping seasons

Impacts of Environmental Factors Soft wheat proteins

Coefficient of variation for:
Total Proteins (TP %),
Unextracatble Polymeric Proteins (UPP)/ TP ratio,
Extractable Proteins/TP ratio,
UPP/EP and
distribution of glutenin subunits

Variables	Genotype														Environment
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
TP	11	12	10	10	12	11	13	10	10	13	12	12	10	14	11
UPP/TP	34	25	33	37	22	36	40	91	50	51	37	36	35	31	40
EP/TP	3	3	4	4	3	4	4	7	5	6	4	4	3	4	4
UPP/EP	38	28	38	42	26	42	43	96	57	59	42	38	39	35	44
HMW	16	9	8	12	14	10	11	10	12	11	12	11	11	8	11
LMW	7	4	3	5	5	4	4	4	23	4	5	4	5	3	6
HMW/LMW	38	13	11	17	23	15	15	15	20	16	17	16	17	11	18

14 Bread wheat cultivars, 11 Locations (7 in France, 4 Europe)

Impacts of Environmental Factors on MWD of Prolamins

A4F-MALS

Genetic (G) and Environmental (E) Influence on Molecular Weight Distribution of Storage Proteins

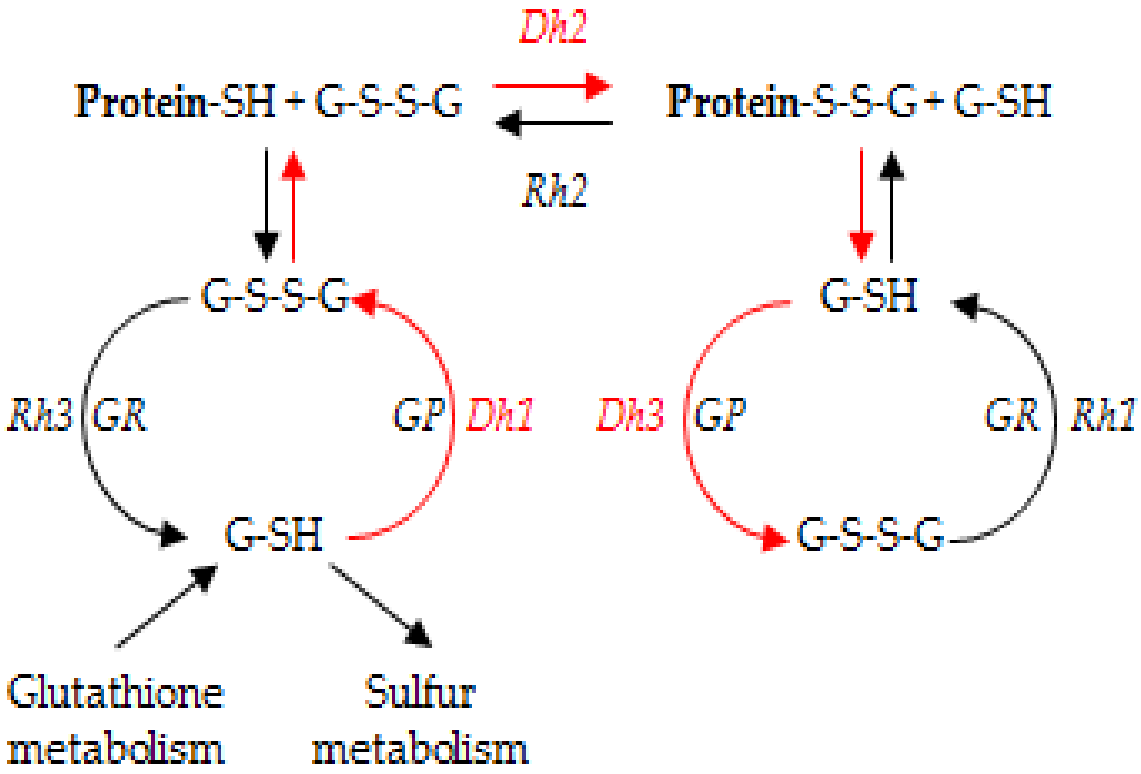
Parameters	Maximum value	Minimum value	Mean value	σ^2_G/σ^2_R	σ^2_E/σ^2_R
Total proteins	8.700	15.100	11.187	11.411***	271.577***
Total polymers	2.785	5.755	4.016	11.104***	187.462***
Polymer/monomer	0.321	0.700	0.561	14.845***	72.611***
Polymer M_n	0.730 $x10^6$	9.609 $x10^6$	0.972 $x10^6$	1.068^{NS}	4.383^{***}
Polymer M_w	1.142 $x10^6$	22.970 $x10^6$	7.640 $x10^6$	3.370***	38.974***

130 Soft wheat genotypes
grown in 3 different environments
during 2 cropping seasons

Impacts of Environmental Factors on MWD of Prolamins

Changes in PP and PP-S-S-G content during the grain development.

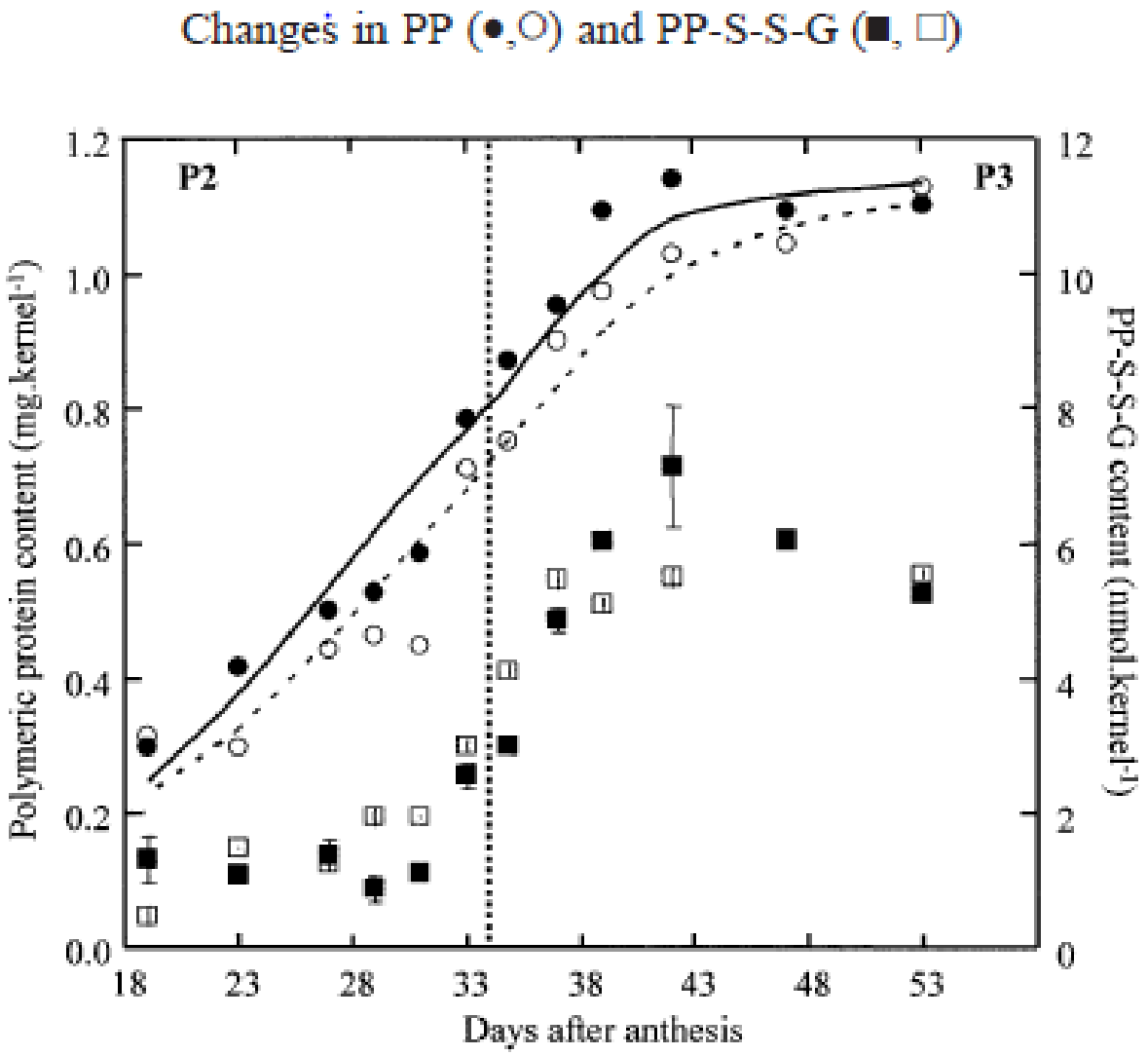
Glutathione disulfide-dependent protection of protein thiol groups during desiccation.



DH, Dehydration steps.
GSH, reduced glutathione;
GSSG, glutathione disulfide;
GR, glutathione reductase.

Impacts of Environmental Factors on MWD of Prolamins

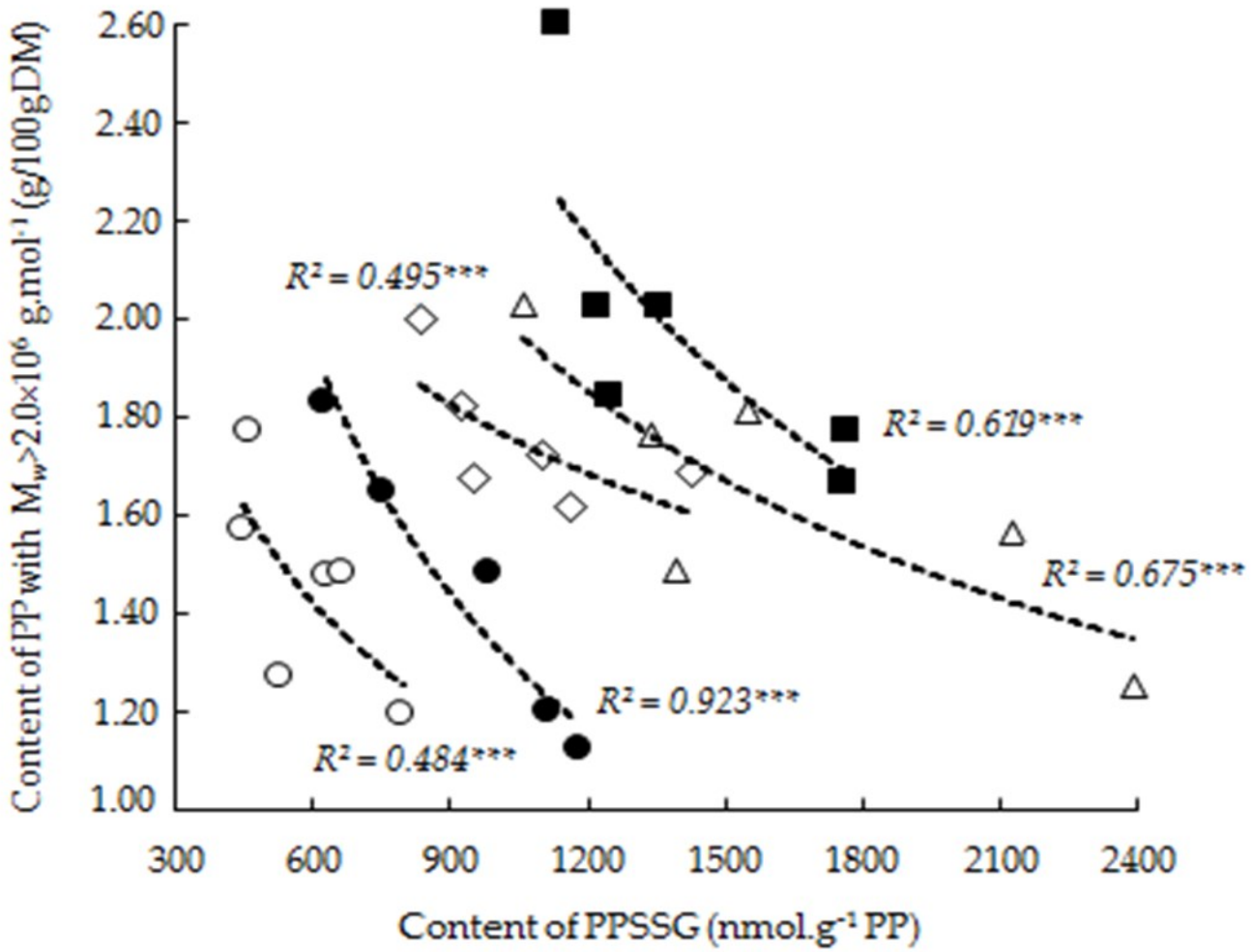
Changes in PP and PP-S-S-G content during the grain development.



Open symbols = cv. Soissons
Closed symbols = cv. Thésée.

Impacts of Environmental Factors on MWD of Prolamins

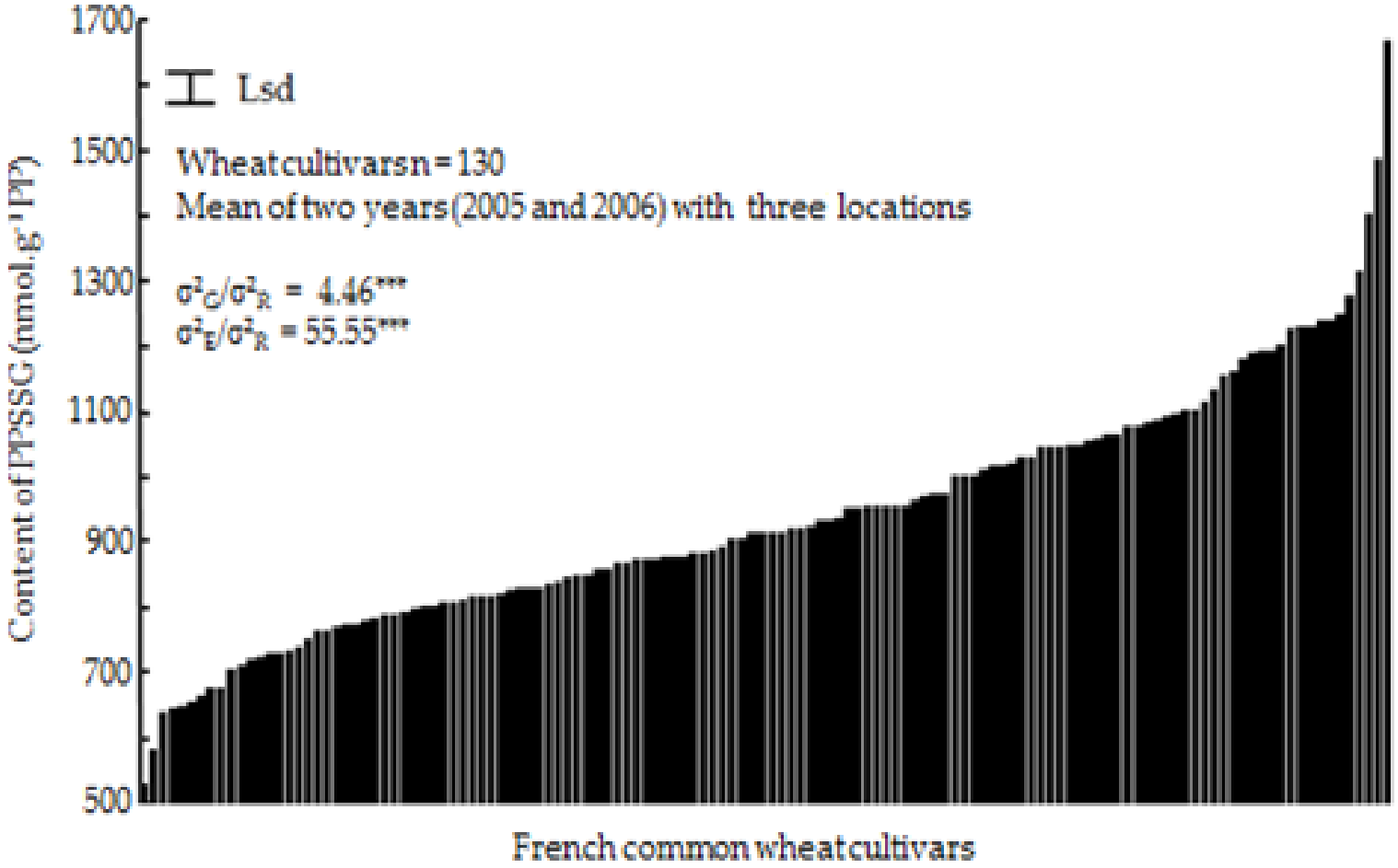
Accumulation of PP and PP-S-S-G: correlations



The relationship between the content of high aggregated polymeric proteins (PP with Mw>2 10^6 g.mol-1)
And
the content of polymeric proteins conjugated to glutathione (PPSSG)

Impacts of Environmental Factors on MWD of Prolamins

Accumulation of PP-S-S-G: Genetic impact



Variation of the content of polymeric proteins conjugated to glutathione (PPSSG) for 130 cultivars

ACKNOWLEDGMENTS

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INAT
Fondé en 1898
Institut National Agronomique de Tunisie

120th Anniversary

THANK YOU FOR YOUR ATTENTION