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## How hardness leads to a soft and fruitful collaboration

Valérie Lullien-Pellerin

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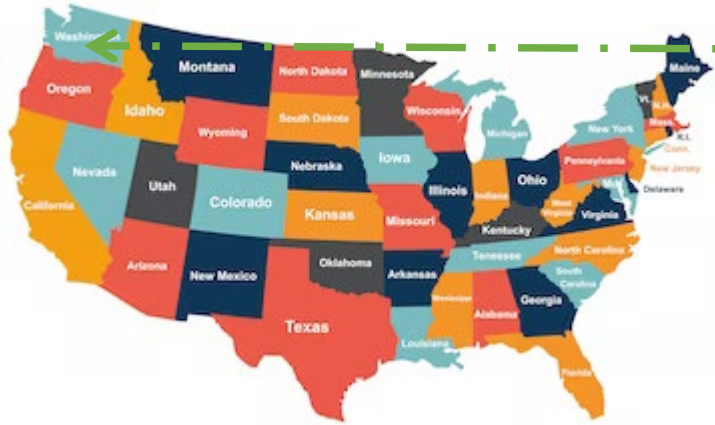
Submitted on 19 Jul 2023

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# ➤ How hardness leads to a soft and fruitful collaboration



**V. LULLIEN-PELLERIN**

[valerie.lullien-pellerin@inrae.fr](mailto:valerie.lullien-pellerin@inrae.fr)

Grain(e)s team-UMR IATE



# > A part of my history in the 90's...



**10 years studying the structure-function relationships of low molecular weight amphiphilic cysteine-rich proteins from wheat grains possibly involved in the product quality**

- cDNA sequences isolation
- Heterologous protein expression for protein purification and structural & functional studies
- Mutagenesis to explore structure effect on functions

LTPs		X	C	X	CX	CC	X	C	X	C	X	C	X			
CM Proteins		X	C	X	C	X	CX	CC	X	C	X	C	X	C	X	
Puroindolines	X	C	X	C	X	C	X	CX	CC	X	C	X	C	X	C	X

**X = n amino-acids**



# > Concomitantly in the Craig's lab. & elsewhere



**Understanding of the molecular basis of grain hardness**

**Identification of starch granules associated proteins** : abundant in soft common wheats, low in hard common wheats and absent in durum wheats (Morris et al., J Cereal Sci.1994)

2 related proteins of 13-15 kDa were identified : **Puroindolines (Pins) A & B**

**Link to the non-sticky character between starch and the protein matrix in soft grains**

**One of them is mutated or absent in hard phenotypes !**



# > Concomitantly in the Craig's lab. & elsewhere



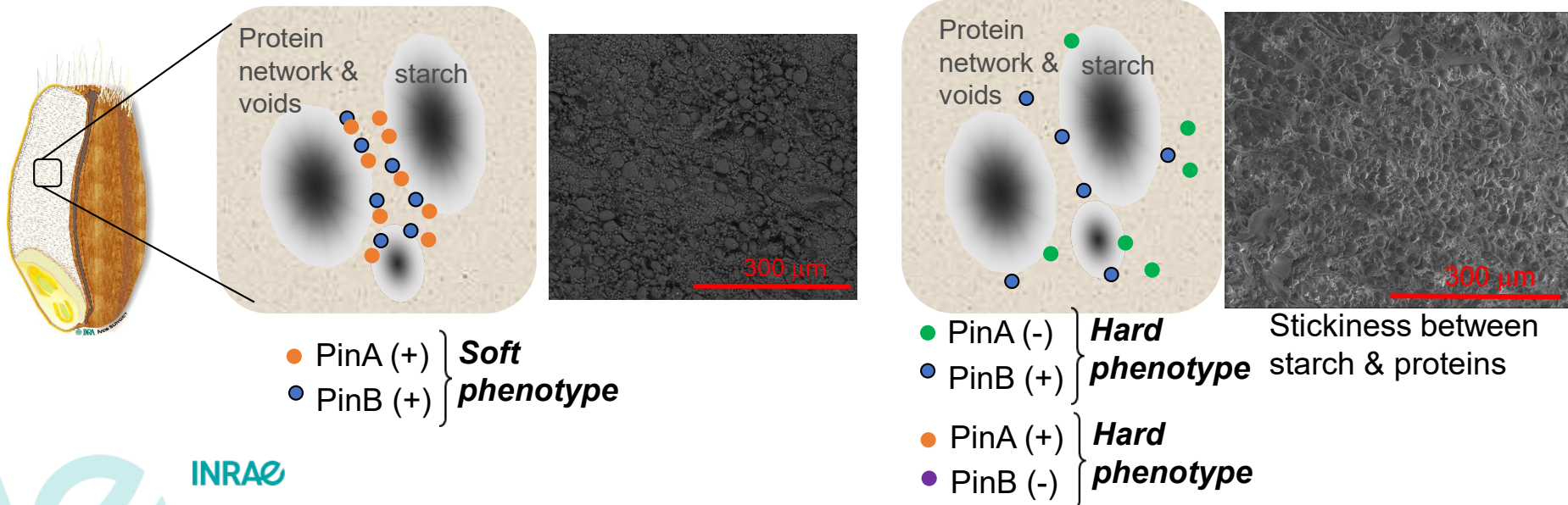
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# ➤ From 2001 : Relying structure/composition/of wheat grains and flour yield & quality



**Studying the milling energy and flour yield & quality depending on both grain hardness and vitreousness**

**Trying to determine the local mechanical properties at the protein-starch interface**

**Modeling of the starchy endosperm rupture**



# ➤ From 2001 : Relying structure/composition/of wheat grains and flour yield & quality



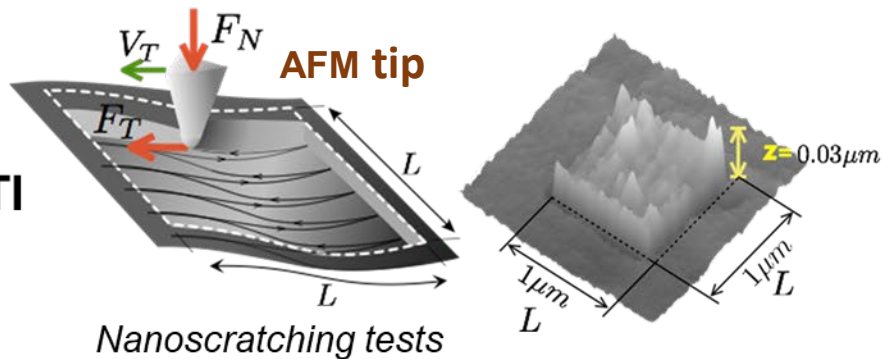
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**Emna  
CHICHTI  
PhD**



**H Starch** =  $2400 \pm 600$  (MPa)  
**H Gluten** =  $640 \pm 170$  (MPa)





# ➤ From 2001 : Relying structure/composition/of wheat grains and flour yield & quality



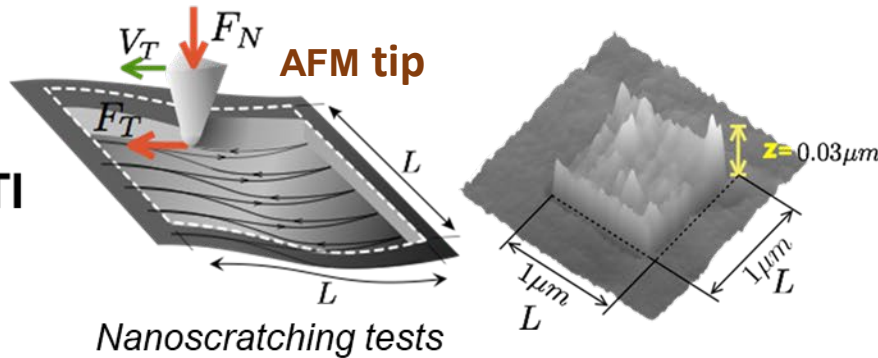
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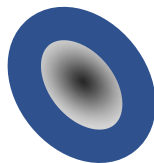


H Starch =  $2400 \pm 600$  (MPa)  
H Gluten =  $640 \pm 170$  (MPa)

Thanks to the study of **near-isogenic common wheat lines** (created in France by F-X Oury) carrying either the wild-type (soft phenotype) or the mutated *Pinb-D1* gene (hard)

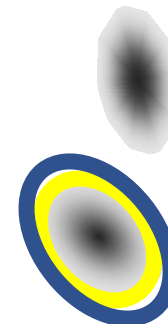
Different interfaces at the starch granules

from **hard** wheats



mainly starch covered with protein

or **soft** wheats



mainly nude starch

or starch with a finer protein layer or with a slipping interface under the protein layer





# ➤ C. Morris venue in Montpellier: E. Chichti PhD defense, Nov. 2013 & start of the collaboration



XIV International Gluten Workshop, Madrid, June 2023  
In memory of C. Morris, Lullien V

# ➤ Collaboration between us.....

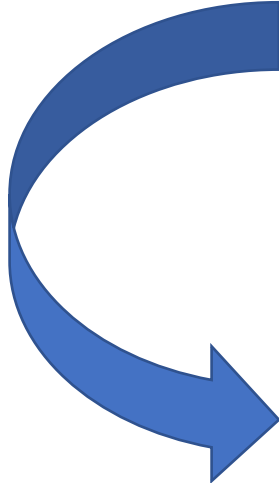


**Near-isogenic common wheat lines** carrying the wild-type *Pinb-D1* gene (soft) or the mutated *Pinb-D1* gene (hard) (Oury et al. TAG, 2015)



***T. durum* (Svevo) + Svevo-Pins** (Morris et al., Crop Sci. 2011)

RESEARCH



**Transfer of Soft Kernel Texture from *Triticum aestivum* to Durum Wheat, *Triticum turgidum* ssp. *durum***

Craig F. Morris,\* Marco C. Simeone, G. E. King, and Domenico Lafiandra

**Studying wheat fractionation depending on Pins**



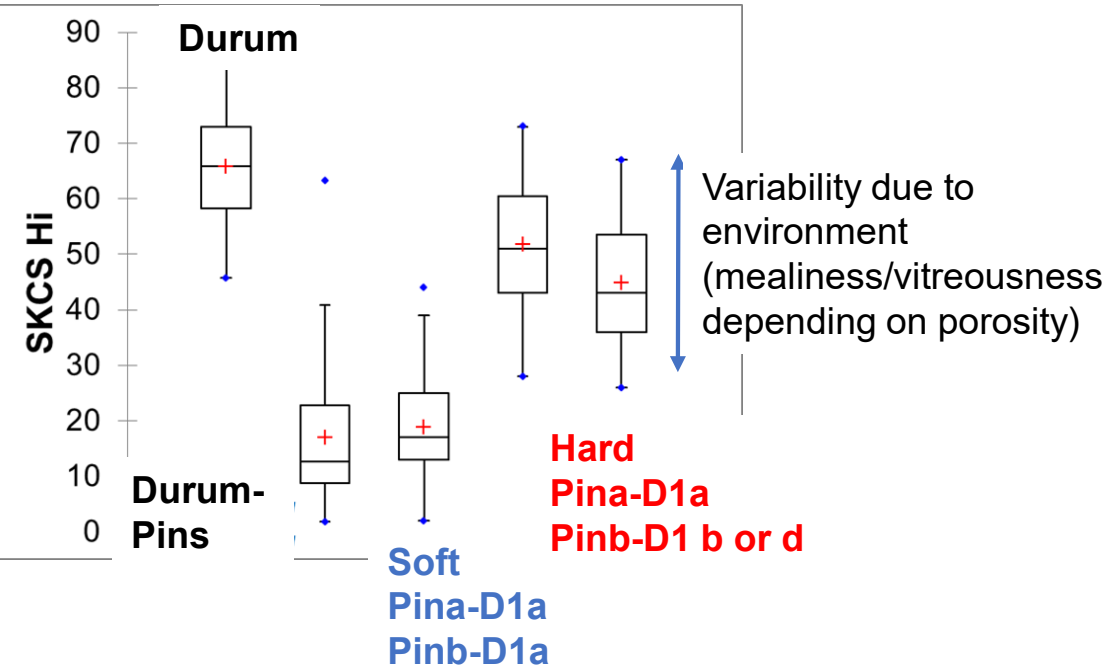
**Karsta Heinze  
PhD**



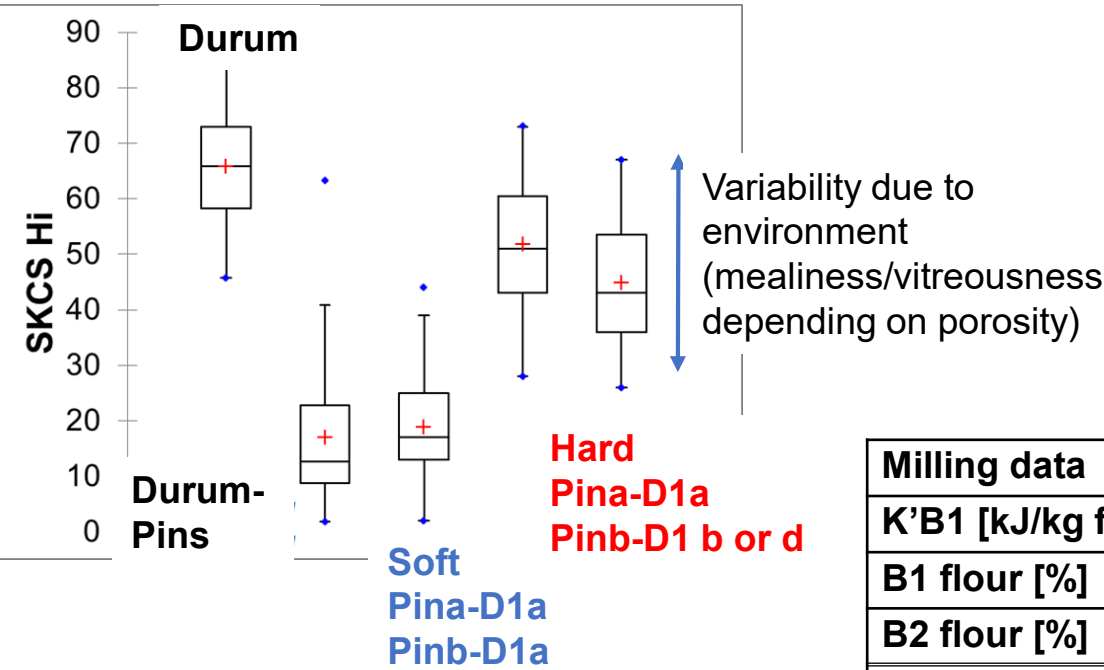
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# ➤ What did we learn about the effect of “wild” Pins



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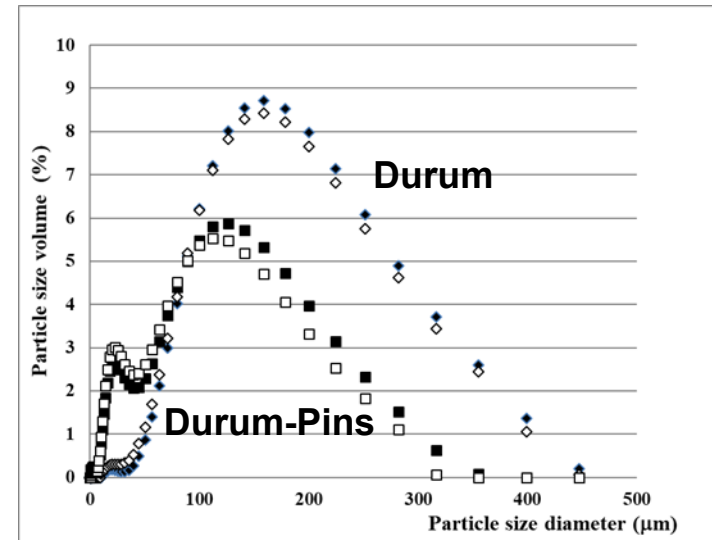
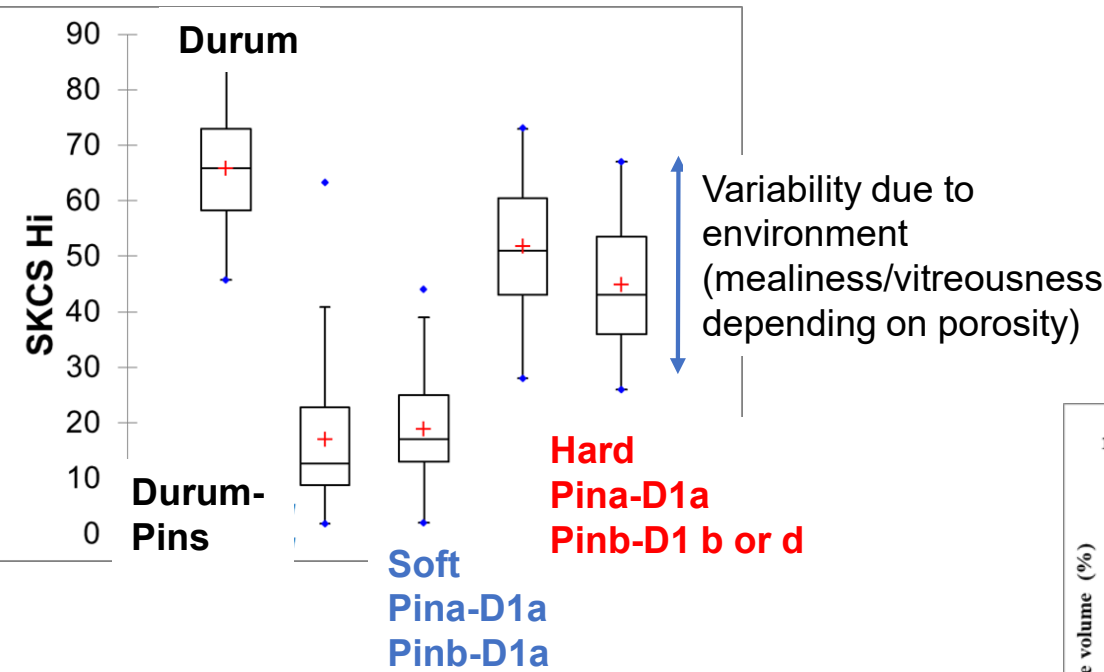


Milling data	<i>Durum</i>	<i>Durum-Pin</i>
K'B1 [kJ/kg flour]	780 (62)	153 (6)
B1 flour [%]	2.0 (0.0)	7.9 (0.8)
B2 flour [%]	6.7 (0.4)	9.8 (1.3)
Total break flour [%]	8.7 (0.4)	17.7 (2.1)
Coarse bran [%]	7.0 (1.2)	21.0 (0.3)

- Decrease the milling E
- Increase flour and coarse bran yield



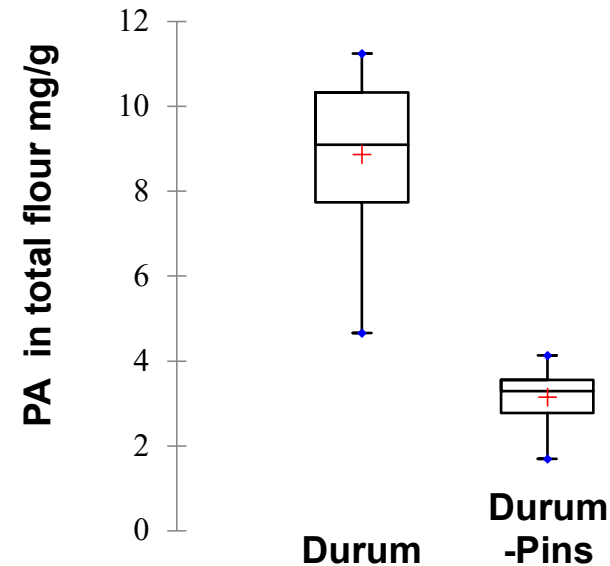
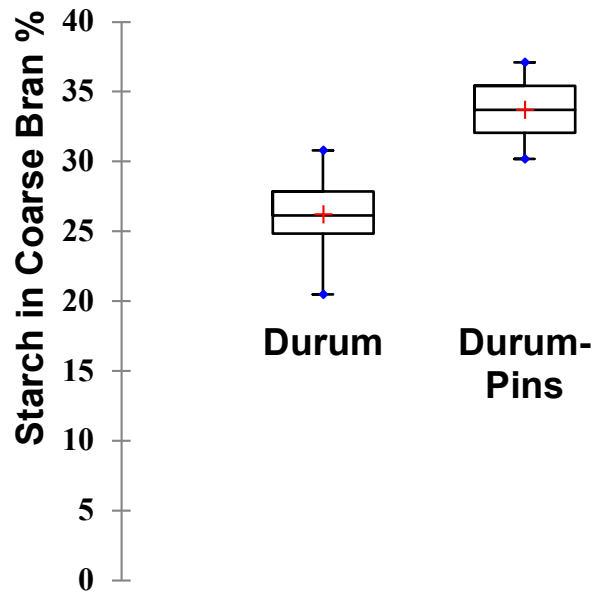
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- Decrease the milling E
- Increase flour and coarse bran yield
- **Change in particle size distribution (from mono to bimodal)**

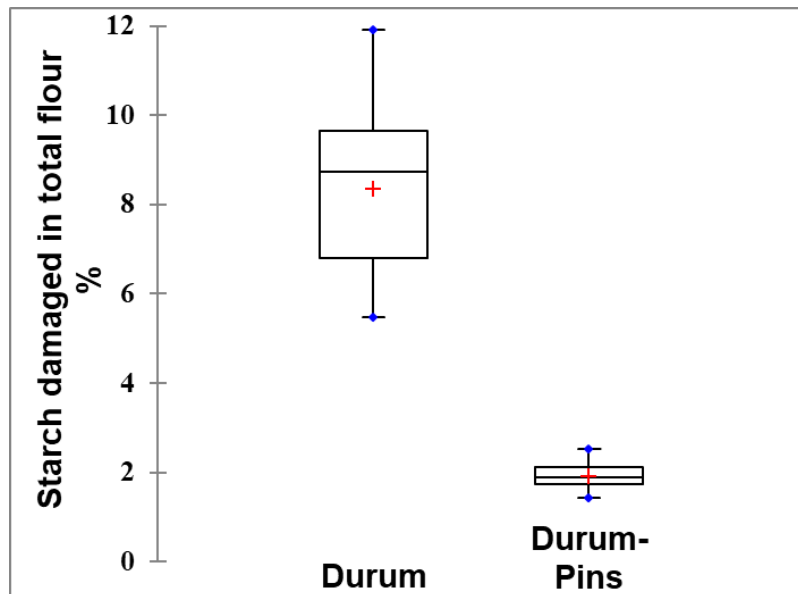


# ➤ What did we learn about the effect of “wild” Pins



- Decrease the milling E
- Increase flour and coarse bran yield
- Change in particle size distribution (from mono to bimodal)
- **Increase starch in coarse bran, decrease aleurone content (measured through phytic acid) in flour**

# ➤ What did we learn about the effect of “wild” Pins



Puroindoline genes introduced into durum wheat reduce milling energy and change milling behavior similar to soft common wheats



K. Heinze <sup>a</sup>, A.M. Kiszonas <sup>b</sup>, J.C. Murray <sup>b</sup>, C.F. Morris <sup>b</sup>, V. Lullien-Pellerin <sup>a, \*</sup>

<sup>a</sup> UMR IATE, CIRAD, INRA, Montpellier SupAgro, Université de Montpellier, F-34060 Montpellier, France  
<sup>b</sup> USDA-ARS, Western Wheat Quality Lab, Washington State University, Pullman, WA 99164-6394, USA

- Decrease the milling E
- Increase flour and coarse bran yield
- Change in particle size distribution (from mono to bimodal)
- Increase starch in coarse bran, **decrease** aleurone content & **damaged starch in flour**

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# ➤ Wheat Initiative expert working group “Improving wheat quality for processing and health”



July 2019, Saskatoon, Canada, 1st International Wheat Congress  
Wheat Quality group in WI managed by C. Guzman & T. Ikeda



Understanding the Mechanics of Wheat Grain Fractionation and the Impact of Puroindolines on Milling and Product Quality

V. Lullien-Pellerin, R. Haraszi, R. S. Anderssen, and C. F. Morris

Gilberto Igrejas  
Tatsuya M. Ikeda  
Carlos Guzmán *Editors*

Wheat Quality  
For Improving  
Processing And  
Human Health

 Springer

<https://link.springer.com/book/10.1007/978-3-030-34163-3>

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## ➤ Never finished.....



Continuing studying the effect of Pins on milling E & grain milling behavior  
(with Alecia Marie Kiszonas in US)

Currently studying the described genetic material under conditions of climatic changes



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➤ *Thanks Craig & al.*



*Pictures V. Lullien, Montpellier 2021-22*



*& for your attention*



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