Debranning process and effects on some traits of durum wheat quality

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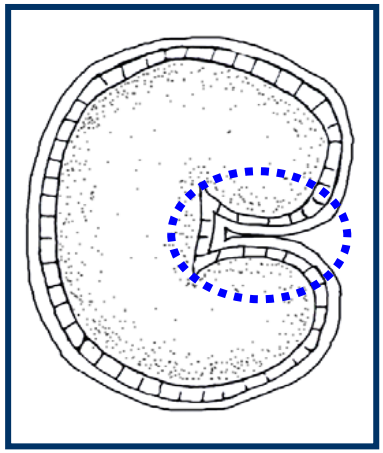
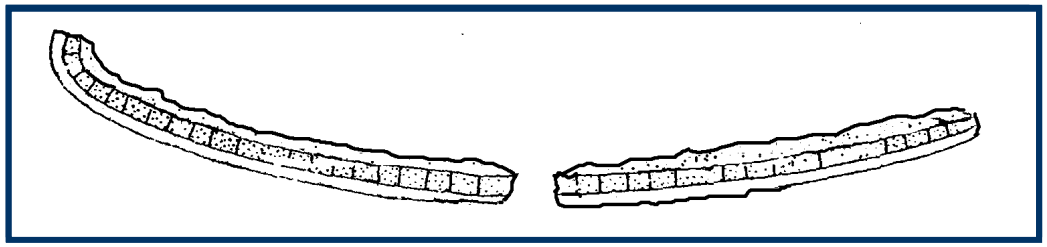
MILLING PROCESS



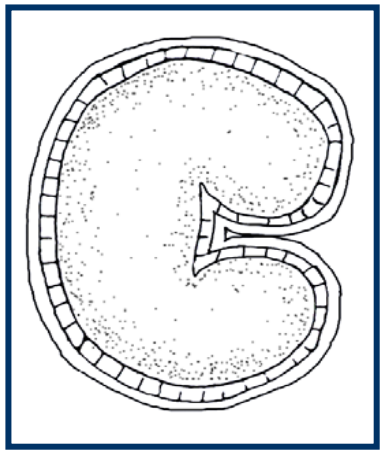
Product:
SEMOLINA

The removal of the tegumental layers proceeds **from the inside towards the outside** of the kernel



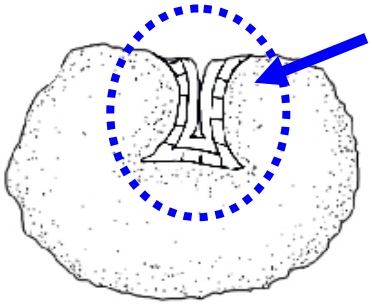
By-products: **BRAN** (mainly) and **GERM**

DEBRANNING PROCESS



Product:
DEBRANNED KERNEL

*The removal of the teguments proceeds, step by step, **from the outermost layers towards the more internal regions**.*
Whatever the debranning level, the crease keeps its teguments.



Advantages of Debranning Process

(Dexter et al.1996)

- ✓ *Increase in semolina yeald*
- ✓ *Higher semolina refinement*
- ✓ *Time reduction of milling process diagram*
- ✓ *Reduction of microbial contamination*

Main objectives of our studies

LABORATORY SCALE

- *Identification of the "optimal" debranning level (DL)*

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"compromise" between higher semolina yield, higher semolina refinement and lower α-amylase activity

- *Identification of pre-treatments improving kernel behaviour during debranning (e.g. kernel humidification)*

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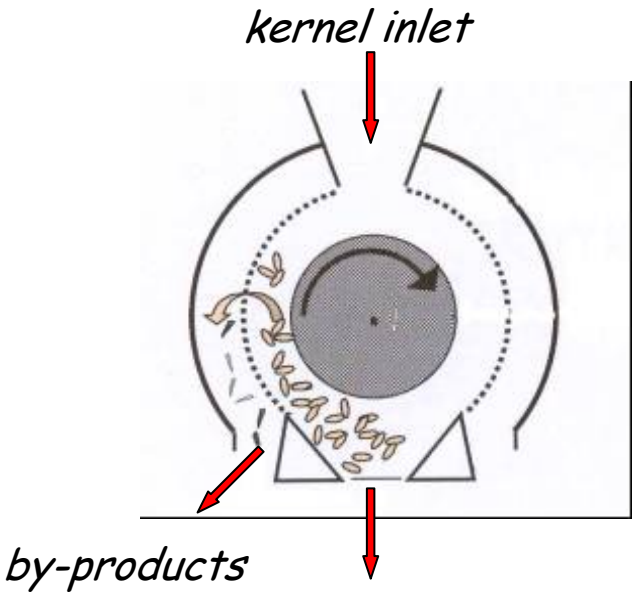
Transfer on industrial scale of the best results obtained on laboratory scale

LABORATORY SCALE

(Pagani et al. 2002)

SB-SA DEBRANNING MACHINE



- Identification of the "optimal" debranning level (DL)
- Effectiveness of pre-treatments (e.g. kernel humidification)

TECHNICAL CHARACTERISTICS:

- Feeding: discontinuous
- Feed rate: 100-150g
- Debranning element : abrasive stone

COMMERCIAL DURUM WHEAT (Italian origin)

Test weight	(kg/hl)	81.5
1000 kernel weight	(g)	49.3
Broken kernels	(%)	4.7
Protein content	(%d.b.)	14.0
Ash content	(%d.b.)	1.97
Starch content	(%d.b.)	69.5
α-amilase activity	(IU/g d.b.)	0.45

EXPERIMENTAL PLAN (laboratory scale)

COMMERCIAL DURUM WHEAT

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SB-SA DEBRANNING Machines — debranning — PROCESS CONDITIONS: Time: 30-180 s; Wetting: 3% H_2O and resting 5-15min

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DEBRANNED KERNELS

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Bühler MLU 202 — milling — Final moisture: 16%; Tempering: 6 hours

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SEMOLINA

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CRA-QCE pilot plant — pasta-making — Drying cycle; LT: 55°C; HT: Tmax 90°C

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PASTA

(Spaghetti shape, ∅ 1 .6 mm)

Evaluation of debranning on kernels, products and by-products

Debranned kernels

- Ash content
- Residual α-amilase activity
- Percentage of broken kernels

Debranning by-products

- Debranning level (DL)
- Ash content
- Starch content

Semolina from debranned kernels

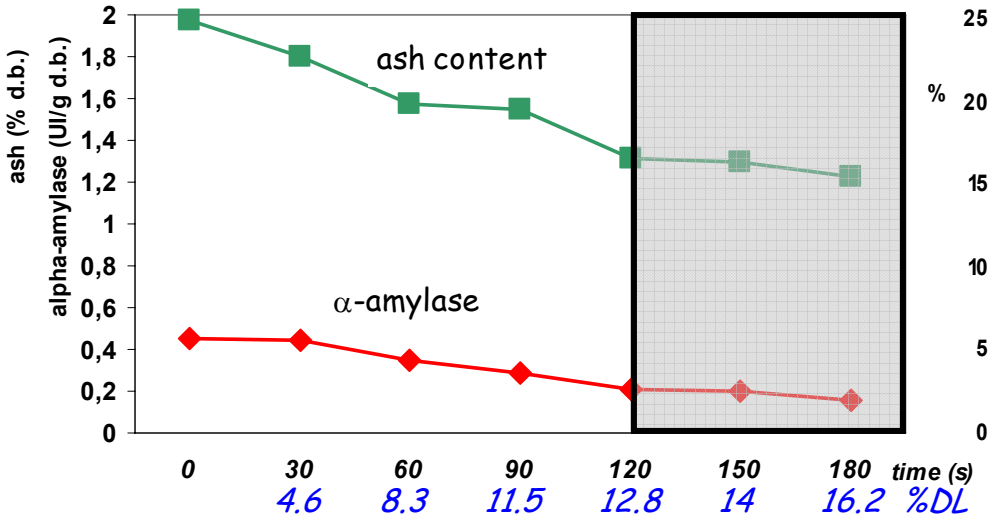
- Evaluation of yield
- Ash content
- Colour (CIE-L*a*b* indices)
- Protein and gluten content
- Gluten quality
- α-amylase activity
- Damage starch

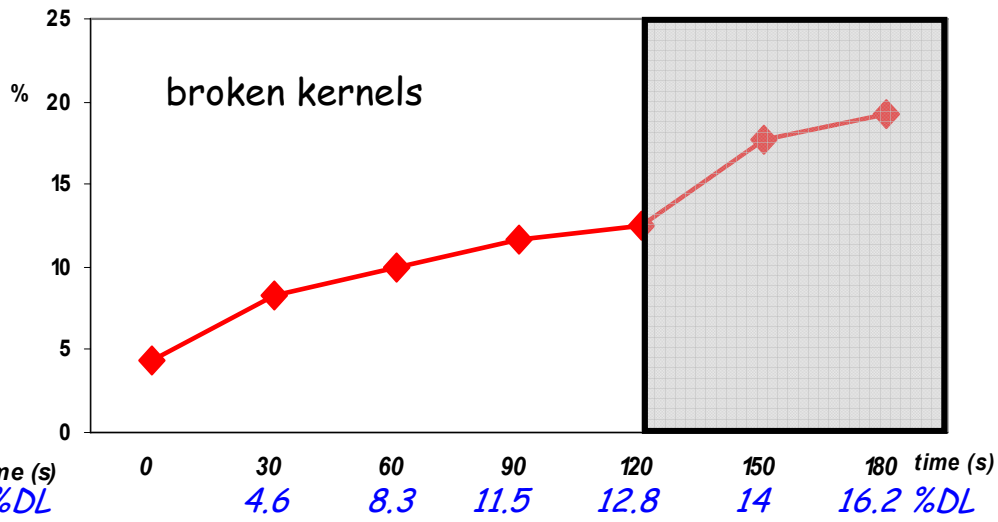
Pasta from debranned kernels

- Sensory test
- Furosine level

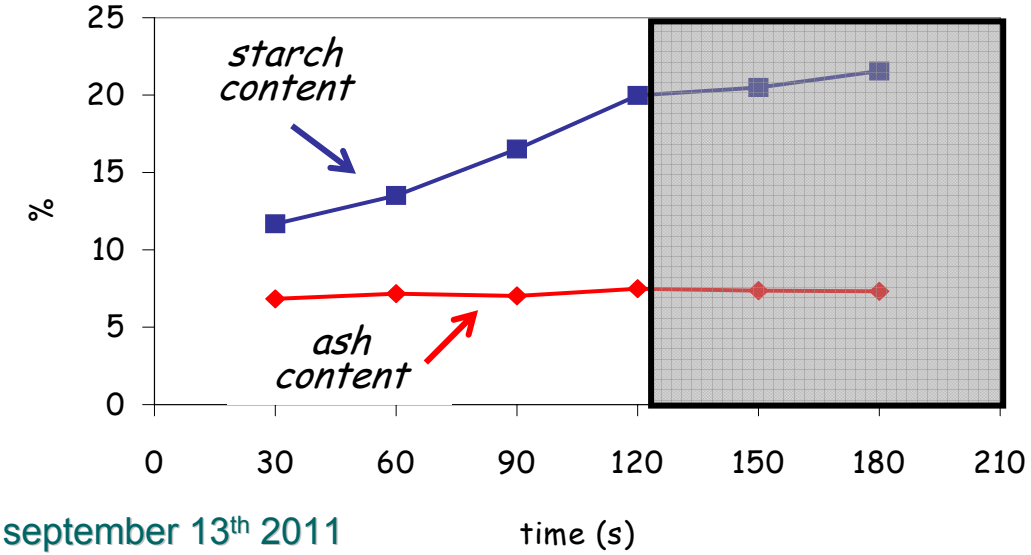
Characteristics of debranned kernel and by-products

DEBRANNED KERNELS





DEBRANNING BY-PRODUCTS



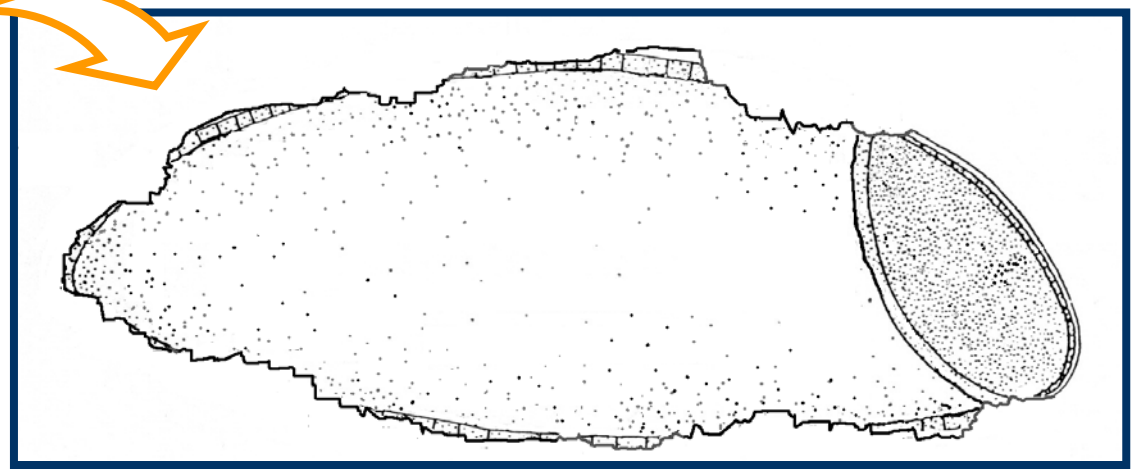
Characteristics of debranned kernel and by-products

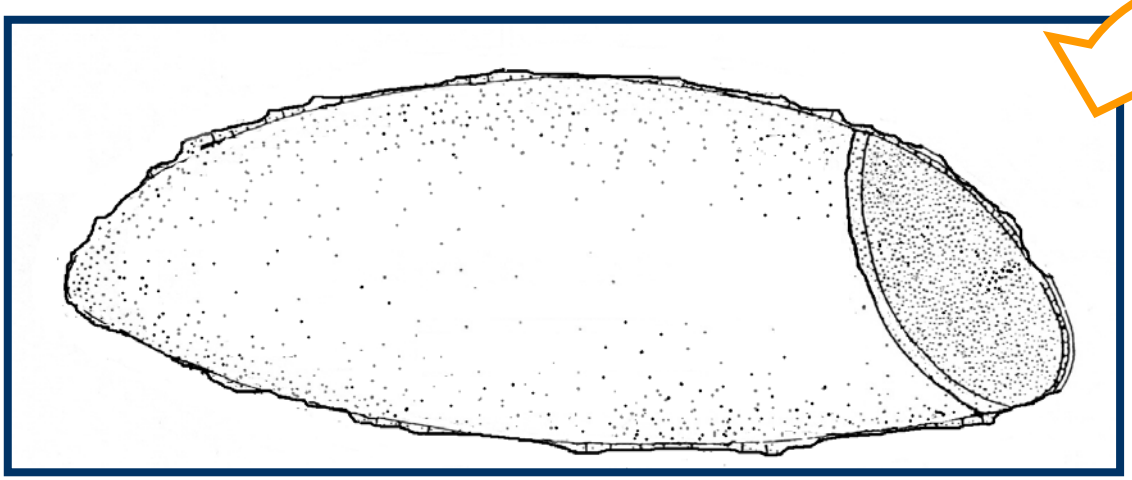
Differences related to pre-hydratation

PRODUCTS	PARAMETERS	DEBRANNING TIME			
		60 s		90 s	
		without H_2O	3% H_2O	without H_2O	3% H_2O
KERNELS	DL%	7.4	9.5	10.0	11.8
	BROKEN KERNELS	10.0	7.5	12.0	9.5
BY-PRODUCTS	STARCH CONTENT (%d.b.)	13.8	11.2	16.3	12.5

Effects associated with different hydratation of teguments

"Dry" debranning



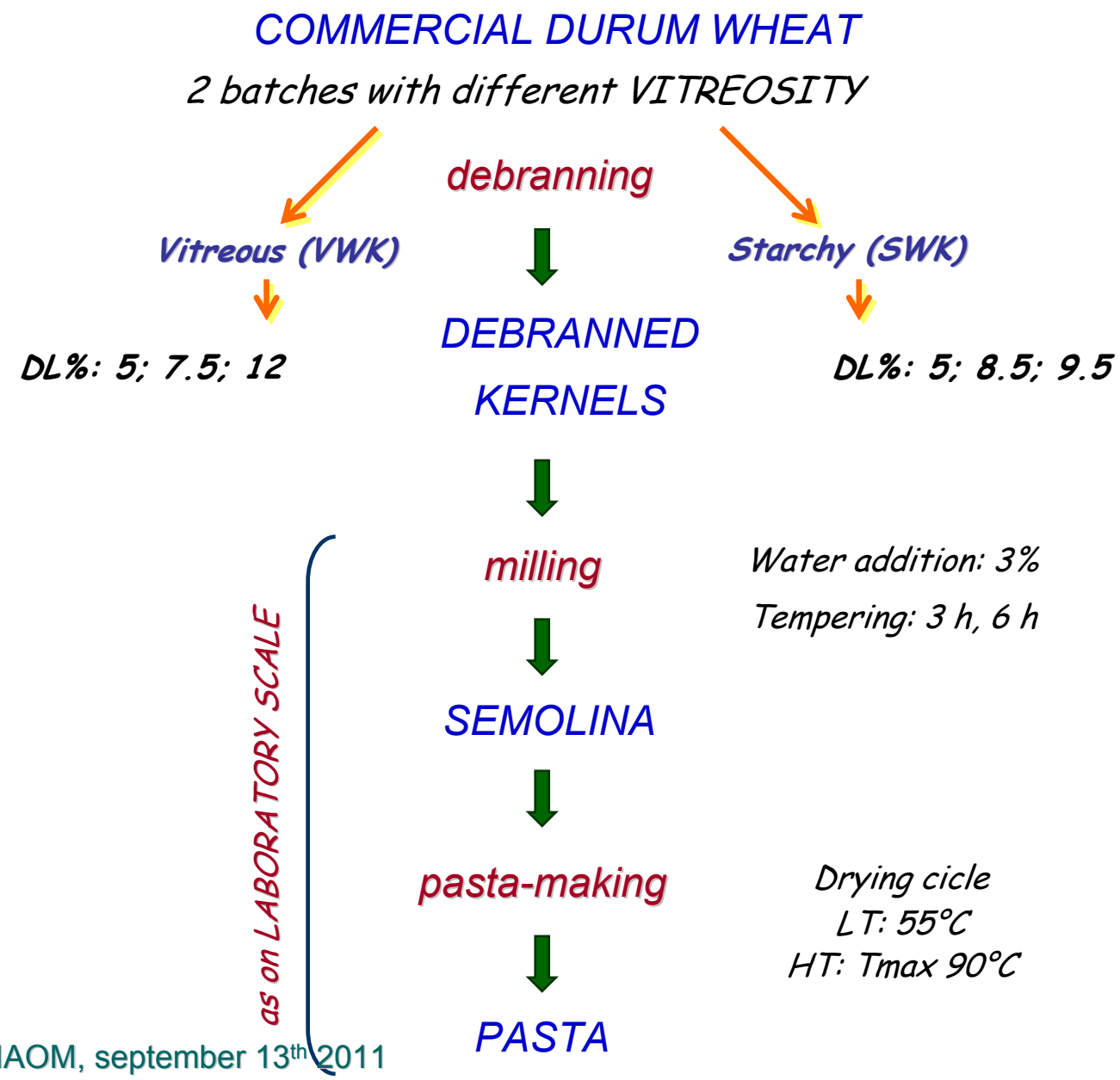


"Wet" debranning

Characteristics of SEMOLINA and PASTA from debranned kernel

PRODUCTS	PARAMETERS	DEBRANNING LEVELS			
		REF	8.2 %	9.6 %	16.2 %
SEMOLINA	YIELDS (%)	70	77.4	75.8	69.4
	b*	17.2	20.8	21.2	21.0
	GLUTEN CONTENT (%d.b.)	9.0	9.9	10.0	9.8
PASTA	COOKING QUALITY (sensory score)	68	75	75	73
	FUROSINE (mg/100g proteins)	504	435	424	417

EXPERIMENTAL PLAN (semi-industrial scale)



Industrial scale: Commercial durum wheat

VITREOUS WHEAT (VWK)	PARAMETERS	STARCHY WHEAT (SWK)
84.0	Test weight (kg/hl)	82.5
< 20	Starchy kernels (%)	44
2.6	Broken kernels (%)	5.2
13.6	Protein content (%d.b.)	14.1
1.99	Ash content (%d.b.)	1.91
61.5	Starch content (%d.b.)	58.5
0.59	α-amylase activity (IU/g d.b.)	0.81

Modifications of kernel components due to debranning: comparison with unprocessed wheat - UPW

(mean values of the percent differences evaluated for the three DLs)

r^2 (DL% vs ash) = -0,983

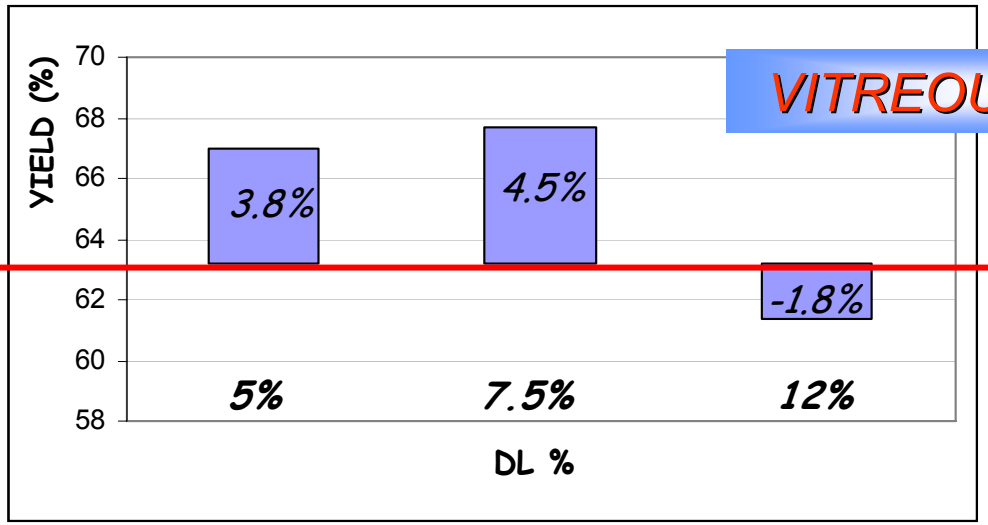
r^2 (DL% vs α-amylase activity) = -0.734

r^2 (DL% vs total starch) = 0.813

r^2 (DL% vs gluten content) = 0.872

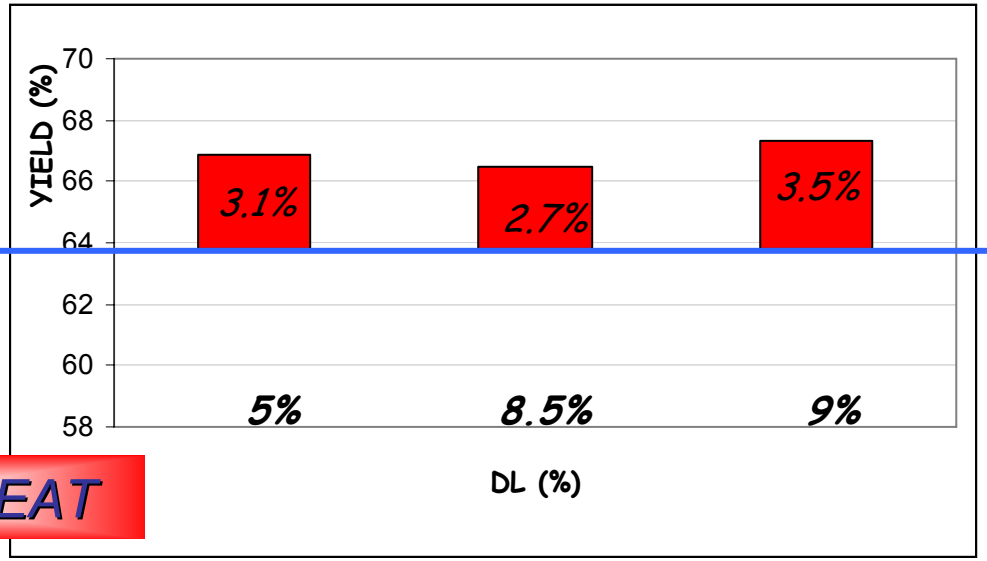
Semolina yield according to the debranning level obtained on industrial scale process (3h conditioning)

(comparison with conventional milling results - data expressed as percent increase in yield)



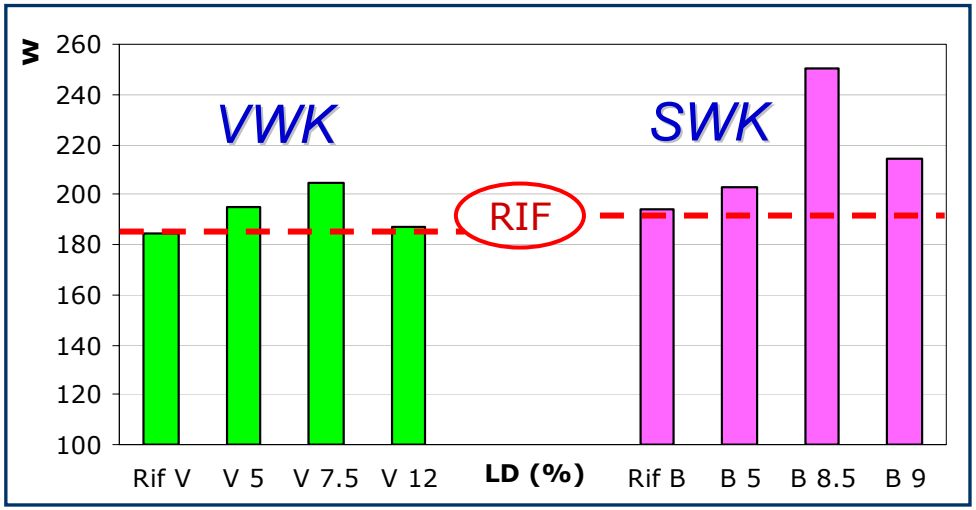
REFERENCE YIELD: 63.2%

REFERENCE YIELD: 63.8 %



STARCHY WHEAT

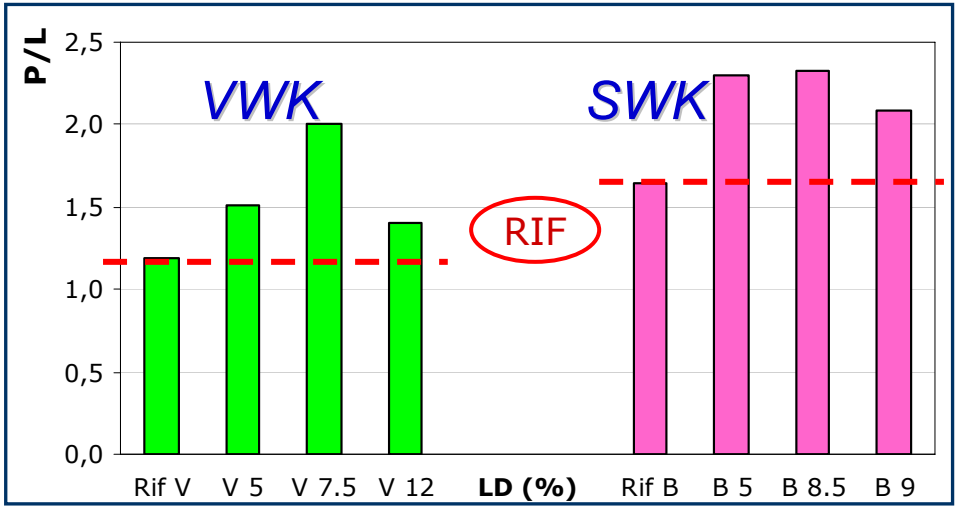
Technological quality



Variation of
alveographic parameters
releted to DL%

W

P/L



Variations in SEMOLINA characteristics

comparison with conventionally milled semolina

(range observed for the three DLs)

	VWK	SWK
Decrease in ash content (%)	6 - 17%	6 - 11 %
Increase in gluten content (%)	3 - 4 %	4 - 10 %
Reduction in α-amylase activity (%)	10 - 13%	15 -30 %

PASTA characteristics (HT - spaghetti)

	VWK				SWK			
DL (%) →	REF	5	7.5	12	REF	5	8.5	9
COOKING QUALITY (sensory score)	73	72	73	73	73	78	76	78
FUROSINE LEVEL (mg/100 g proteins)	553	479	470	475	506	446	397	429

Debranning and safety

(Torri 2002 – MSc thesis in Food Sciences, Milan)

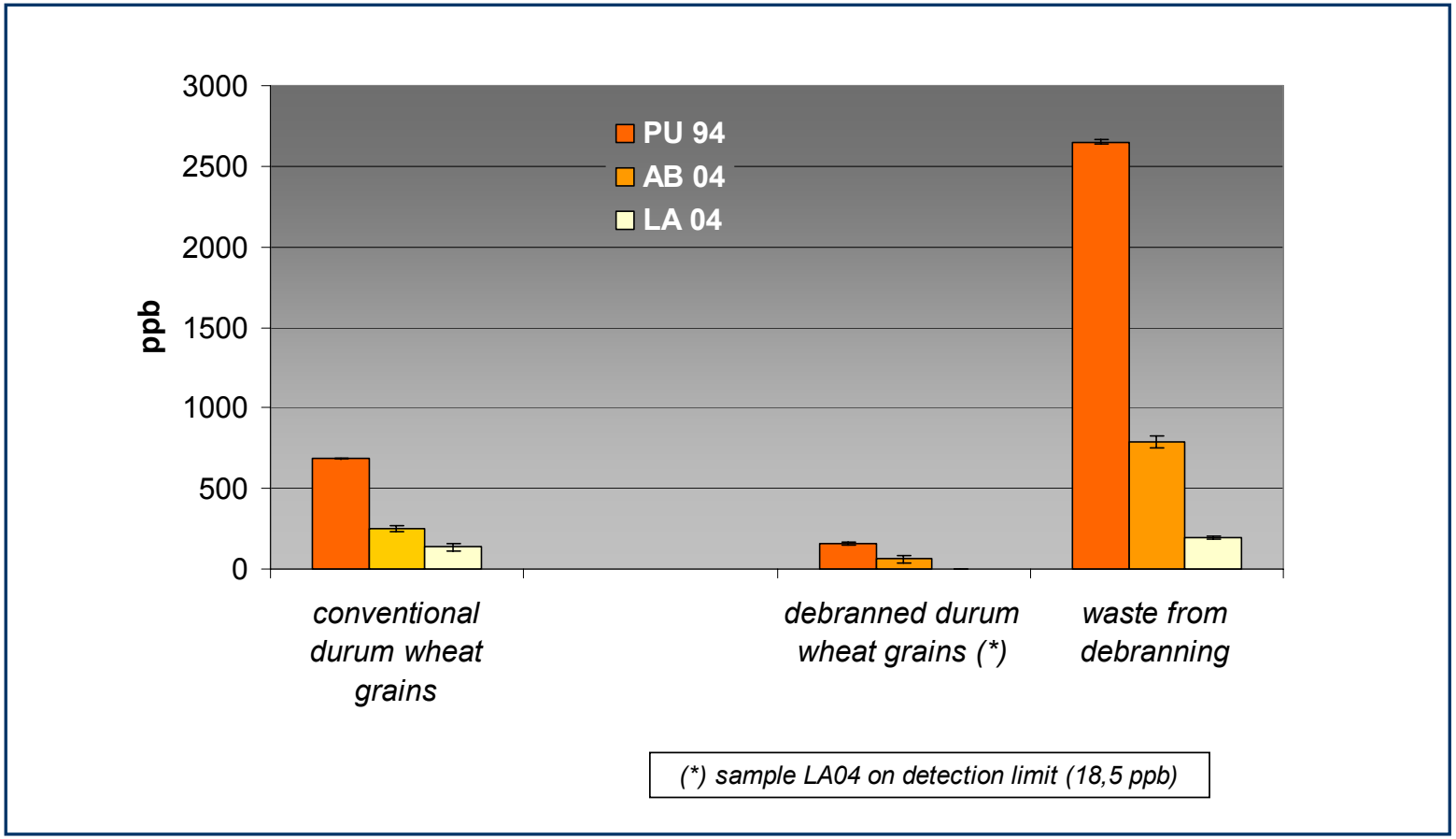
Microbiological quality

	CBT (ufc/g)	Yeast (ufc/g)	Mold (ufc/g)
KERNELS			
Reference	2.4×10^5	600	100
Debr. 2.5%	6.0×10^4	652	< 10
SEMOLINA			
Reference	1.2×10^5	3875	300
Debr. 2.5%	2.6×10^4	1775	60

Mycotoxin contamination

(Aureli, D'Egidio 2007)

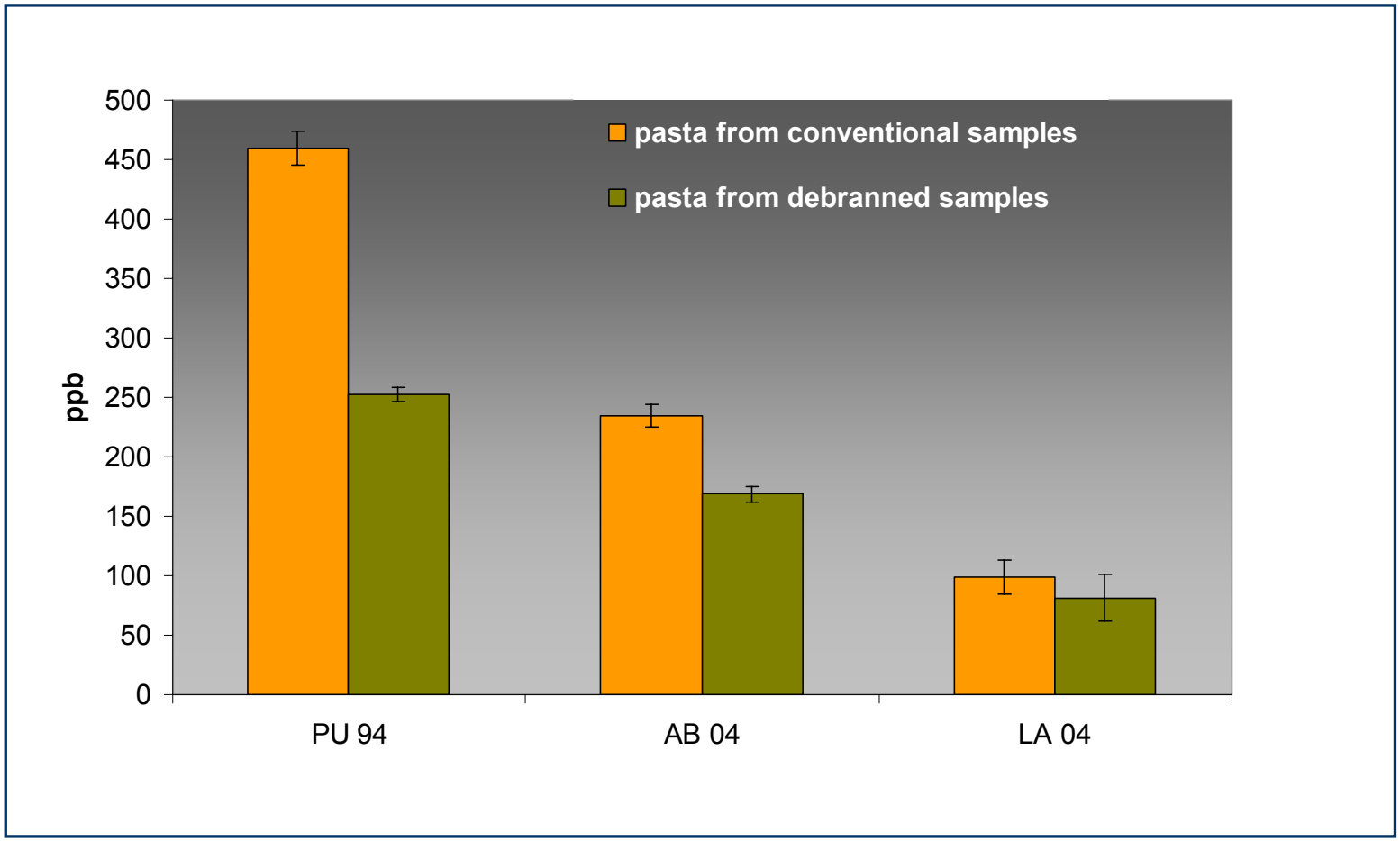
Deoxynivalenol (DON) in untreated and debranned durum wheat



Mycotoxin contamination

(Aureli, D'Egidio 2007)

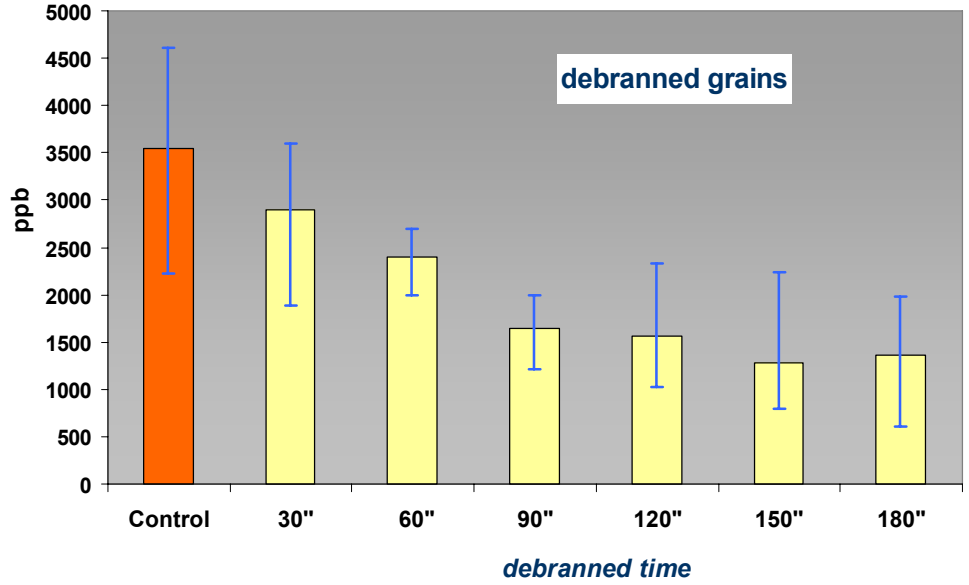
Deoxynivalenol (DON) in pasta from untreated and debranned durum wheat

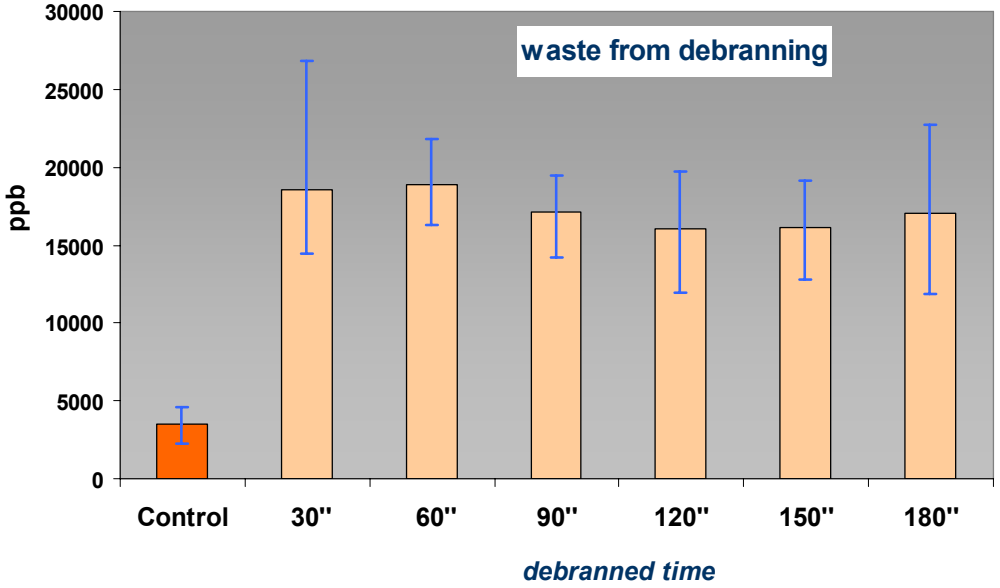


Deoxynivalenol (DON) in untreated and debranned durum wheat

(average value of 6 cultivar)

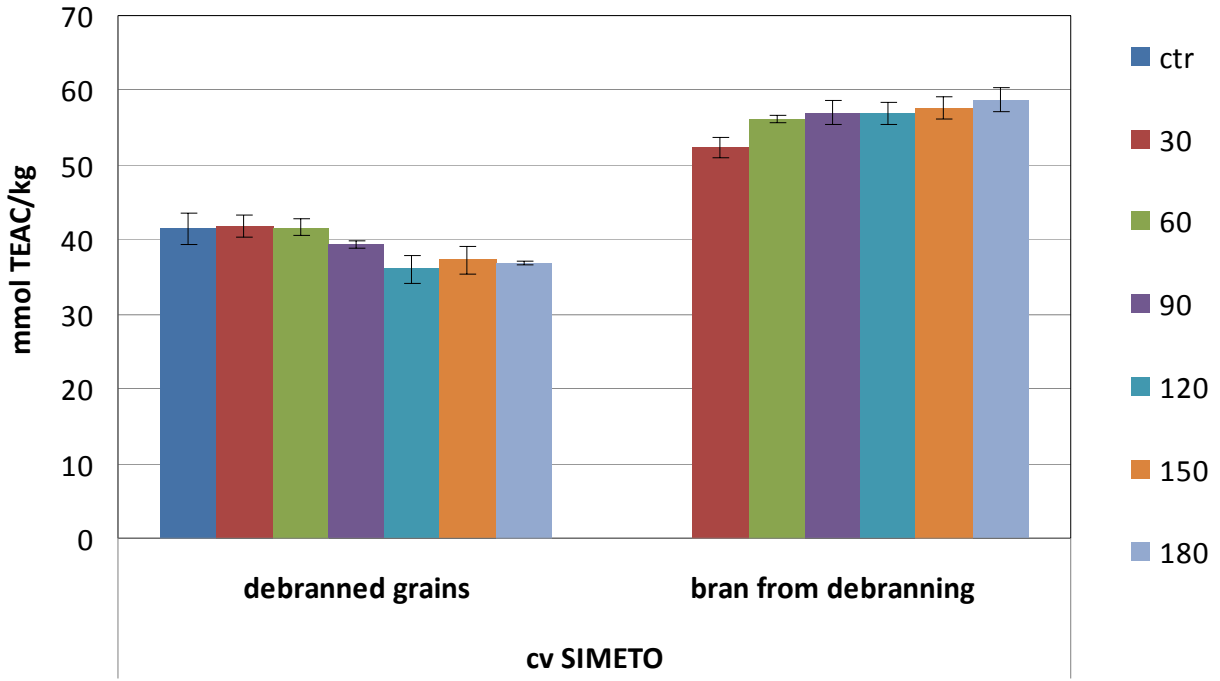
CRA-QCE research in progress





Debranning and health quality

CRA-QCE research in progress



CONCLUSIONS

- *Debranning is advantageous if DL is lower than 10 – 12 %. This process can assure a higher yield and better semolina characteristics than conventional milling*
- *A quick hydration step before processing assures better results*

- *Positive results can be obtained also with starchy wheat kernels*

- *Debranning determined a reduction of DON amount in the kernels, but also bioactive compounds.*
- *An optimization of experimental conditions should be performed in order to preserve compound of nutritional interest and to reduce mycotoxin contamination.*