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Calidad de Sémolas y Pasta

Pasta cooking quality: the role of raw material and the effect of processing

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DeFENS

Pasta: an evolving product

- 1980 – Pasta from durum wheat semolina: Yellow color, «Al dente» firmness
- 2000 – Gluten-free pasta: Exclude gluten from the diet of people affected by celiac disease
- 2015 – Wholegrain pasta, Pulse pasta: Enrichment in fiber, proteins, etc
- Today – Pre-cooked pasta: Ready-to-eat meals

- Simplicity of formulation (only 2 ingredients)
- Low cost and long shelf-life (3 years)
- Easy preparation and adaptability to different tastes and traditions
- Balanced from a nutritional standpoint (sauces)
- Low *glyceamic index*
- From a basic food to a "functional food"

Cooking quality:
- Low cooking loss
- Al dente firmness *(degree of resistance to the first bite)*
- Absence of stickiness *(force with which it adheres to other materials)*
- Low bulkiness *(adhesion rate of cooked pasta strands among them)*

Cooking quality

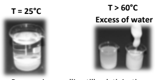
GLUTEN

T = 25°C | T > 60°C

- Interaction till complete coagulation
- Formation of an undeformable network
- Keeping the starch materials inside the pasta

STARCH

T = 25°C | T > 60°C Excess of water



- Progressive swelling till gelatinisation
- Partial solubilisation
- Dispersion of starch materials on pasta surface and into cooking water

Cooking quality:
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- Al dente firmness *(degree of resistance to the first bite)*
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Cooking quality

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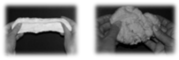

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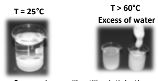
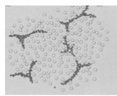


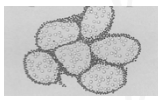
- Progressive swelling till gelatinisation
- Partial solubilisation
- Dispersion of starch materials on pasta surface and into cooking water

- If starch gelatinization prevails on protein coagulation



POOR COOKING QUALITY

- If protein coagulation contains starch gelatinization

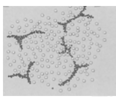


GOOD COOKING QUALITY

Cooking quality

- Raw materials
- Processing conditions

- If starch gelatinization prevails on protein coagulation



POOR COOKING QUALITY

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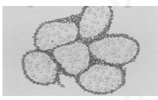
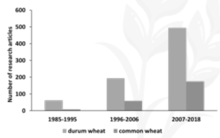


GOOD COOKING QUALITY

The role of raw materials

- 1980 – Pasta from durum wheat semolina
- 2000 – Gluten-free pasta
- 2015 – Wholegrain pasta, Pulse pasta
- Today – Pre-cooked pasta

Durum wheat semolina



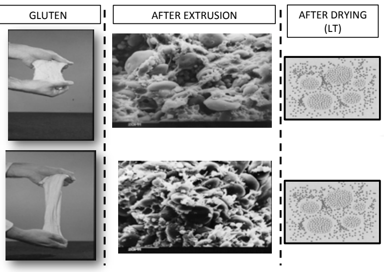
Key words: pasta and durum wheat; pasta and common wheat

The role of raw materials & processing

GLUTEN | AFTER EXTRUSION | AFTER DRYING (LT)

DURUM WHEAT

COMMON WHEAT or poor quality semolina



Semolina

Water → **KNEADING** → ***EXTRUSION*** 45 ÷ 55° C max; 90 120 atm (~ 10 MPa) → ***DRYING*** 4 24 hours and more; HT cycles: till 90°C; LT cycles:50-55°C → **Dried Pasta**

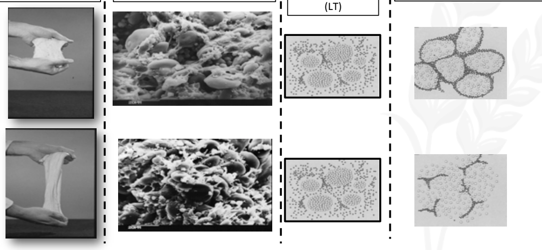
Transforming **semolina** - a mass without cohesion - into a **dough** that is shaped into **fresh pasta** (characterized by 30% moisture content and, consequently, by a short shelf-life) and stabilized by drying in **dried pasta** (moisture content=12.5%; shelf-life >3 years)

The role of raw materials & processing

GLUTEN | AFTER EXTRUSION | AFTER DRYING (LT) | AFTER COOKING

DURUM WHEAT

COMMON WHEAT or poor quality semolina

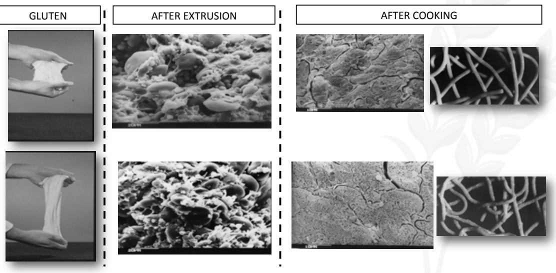


The role of raw materials & processing

GLUTEN | AFTER EXTRUSION | AFTER COOKING

DURUM WHEAT

COMMON WHEAT or poor quality semolina

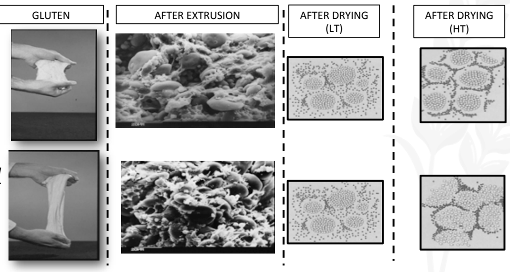


The role of raw materials & processing

GLUTEN | AFTER EXTRUSION | AFTER DRYING (LT) | AFTER DRYING (HT)

DURUM WHEAT

COMMON WHEAT or poor quality semolina



The role of raw materials & processing

HT drying – Issues:

- Heat-Damage: loss of lysine bioavailability
  formation of new molecules (?)
  sensory modifications

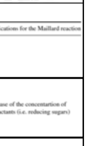
- *prot., the amount of unavailable Lysine is 30 - 50%!*

Cooking Properties and Heat Damage of Dried Pasta as Influenced by Raw Material Characteristics and Processing Conditions

IVANO DE NONI and MARIA A. PAGANI

Table 1 Maillard reaction in dried pasta

Reaction stage	Compounds involved	Produced derivatives	Determined molecule
Early	Reaction of: maltose, maltotriose, glucose or fructose with lysine residues	Protein-bound lysylketoses	Furosine
Advanced	Degradation of: free maltulosyl-amino acids	Glucosylisomaltol (AGPF)	AGPF
	Protein-bound lysylketoses	Protein-bound lysylpyrrolaldehyde (ε-PL)	(ε-PL)



R: lysine residue
R[1]: glucosyl residue

The role of raw materials & processing

PARAMETERS OF SEMOLINA QUALITY
from the pasta-maker point-of-view

- Gluten tenacity and strength
- Color
- Ash content
- Particle size
- Damaged starch
- Amylase activity

PARAMETERS OF PASTA QUALITY
from the consumer point-of-view

- cooking behaviour
- typical yellow color
- absence of defects *(black, brown specks and white spots)*

Cooking Properties and Heat Damage of Dried Pasta as Influenced by Raw Material Characteristics and Processing Conditions

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Table 2 Modifications promoted by each steps of pasta production chain and their implications in the Maillard reaction

Production step	Product	Possible modifications	Implications for the Maillard reaction
Field cultivation and grain storage	Kernel	Sprouting Increase of enzymes content; Enzymatic phenomena (amylolysis and proteolysis)	
Debranning	Kernel	Reduction of amylases and increase of damaged starch	
Milling	Semolina		
- High extraction rate		Concentration of amylolytic enzymes; Increase of products from enzymatic activity	Increase of the concentartion of reactants (i.e. reducing sugars)
- Fine granulometry		High damage of starch granules which promote higher susceptibility to amylase activity	
Storage	Semolina	Enzymatic activities continue	
Kneading and extrusion	Fresh pasta	Important amylase activity	
Drying	Dried pasta	Interactions of reducing sugars with free amino groups	Activation energy for Maillard reaction (early and advanced stage)
Storage	Dried pasta	The Maillard reaction goes on	Accumulation of reaction products

The role of raw materials & processing

PARAMETERS OF SEMOLINA QUALITY *from the pasta-maker point-of-view*	PARAMETERS OF PASTA QUALITY from the consumer point-of-view

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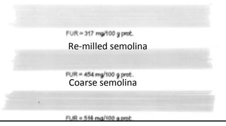
- *The higher the extraction rate, the higher the ash content and amylase activity*
- *The finer the particle size, the higher the damaged starch content*

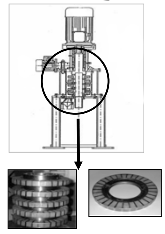


Semolina: α-amilases = 0.13-0.20 UI/g; Damaged starch = 4.7 – 5.5%

Re-milled semolina: α-amilases = 0.13-0.20 UI/g; Damaged starch = > 10 %

Coarse semolina: α-amilases = 0.4-0.7 UI/g; Damaged starch = 7-10 %

The role of processing: debranning

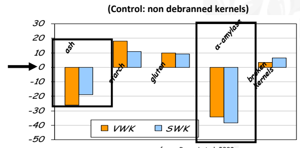


abrasive rolls covered by innovative material: synthetic diamond powder

- Principle: Sequential and controlled removal of grain layers by abrasion (pearling)
- Advantages:
  - Decrease in ash content
  - Decrease in amylase activity

CHANGES OF CHEMICAL AND TECHNOLOGICAL INDICES PROMOTED BY DEBRANNING

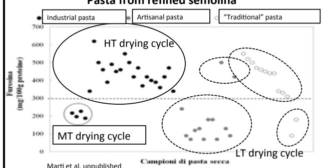
(Control: non debranned kernels)



from: Pagani et al, 2002

The role of raw materials & processing

Pasta from refined semolina

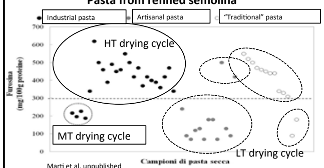


Marti et al. unpublished

	Min	Max	Average	Median
Industrial pasta (n=20)	340	620	441	435
Artisanal pasta (n=13)	*70*	*500*	*176*	*130*

The role of raw materials & processing

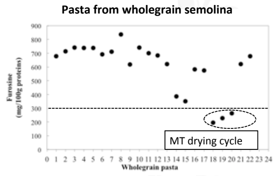
Pasta from refined semolina



Marti et al. unpublished

	Min	Max	Average	Median
Refined semolina pasta (n=20)	340	620	441	435
Wholegrain pasta (n=13)	*195*	*836*	*595*	*678*

Pasta from wholegrain semolina

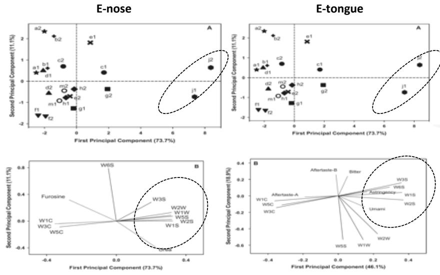


Characterization of Whole Grain Pasta: Integrating Physical, Chemical, Molecular, and Instrumental Sensory Approaches

Alessandra Marti, Stefano Cattaneo, Simona Benedetti, Susanna Buratti, Parisa Abbasi Parizad, Fabio Masotti, Stefania Iametti, and Maria Ambrogina Pagani

The role of raw materials & processing

E-nose **E-tongue**



"The e-senses results demonstrate that the low-temperature dried pasta can be easily discriminated from the high-temperature dried samples. The high temperature treated samples were perceived more bitter and were characterized by e-nose sensors specific for aromatic compounds."

Marti et al. J Food Science, 2017, 82, 2583-2590

The role of raw materials

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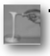
Measuring gluten strength

Test	Principle	Time required	Sample amount
Gluten Index	It measures the amount of wet gluten remaining on a specially constructed sieve after centrifugation under standardized conditions	~15 min	10g
Glutograph	It measures the extensibility and elasicity of washed wet gluten, isolated from flour/semolina	~15 min	10g
Alveograph	It measures resistance to 3-D extension of a thin sheet of dough prepared at a constant hydration level (43.3%)	~50-60min	250g
GlutoPeak	It measures torque and time required for gluten aggregation	~5 min	8.5-10g



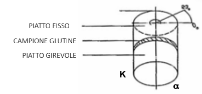

Measuring gluten strength: the Glutograph test

It measures the **extensibility and elasticity of washed wet gluten**, isolated from flour/semolina



- Extensibility: the gluten network deforms instead of break

- Elasticity: the gluten network is able to resume its shape after being stretched



K – FORZA TANGENZIALE RISULTANTE NELLO SFORZO DI TAGLIO DEL CAMPIONE DI GLUTINE
α – ANGOLO DELLO SFORZO CORRESPONDENTE A 0-1000 BU

The measuring system consists of two parallel, round, corrugated plates mounted at a defined distance opposite to each other.

The sample is put in between these two plates.

While the upper plate stands still, the lower one is turned with a constant force - independent of shear angle and sample.

Measuring gluten strength: the Glutograph test

It measures the **extensibility and elasticity of washed wet gluten**, isolated from flour/semolina

- Extensibility: the gluten network deforms instead of break

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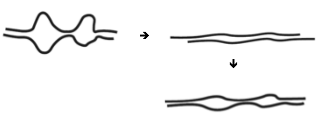
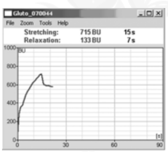
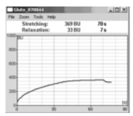




Measuring gluten strength

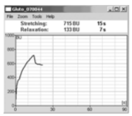
GLUTEN | GLUTOGRAPH

DURUM WHEAT

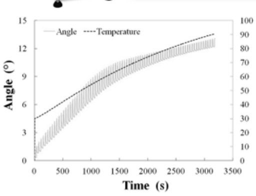
→ Resistant to extension

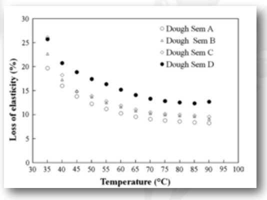
COMMON WHEAT or poor quality semolina

→ Extensible and elastic gluten

Measuring gluten strength: the Glutograph test





High loss values correspond to low firmness and, likely, to "weak" material structures whereas low values are representative of high firmness and strong (stiff) structures

Measuring gluten strength

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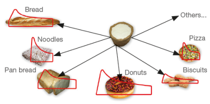
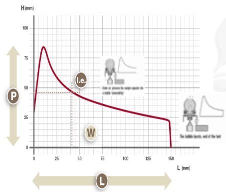
Measuring gluten strength: the Alveograph test

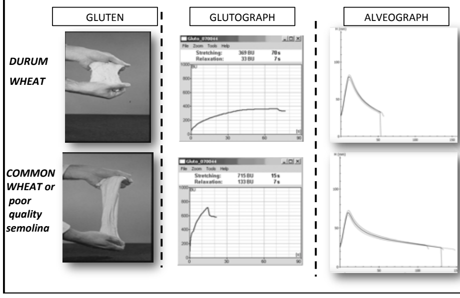
It measures **resistance to 3-D extension** of a thin sheet of dough, prepared at a constant hydration level





P = Tenacity (resistance to extension)
L = extensibility
W = baking strength (curve area)
Ie = P200/P, elasticity index (P200: pressure 4 cm from the start of the curve, Ie will be 0 if the extensibility is shorter than 4 cm)

Measuring gluten strength



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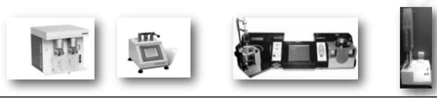

Measuring gluten strength: the GlutoPeak test

It measures the **gluten aggregation** properties

- Rapid (<5 min)
- Small-scale (<10g)
- High shear-based (up to 3,000 rpm)
- No sample prep
- Easy to clean

Description how to run the new test

1. Insert the paddle into the device (Fig. 1)
2. 10g solvent (water) will be weighed out in the sample cup
3. The cup will be placed in the instrument (Fig. 2)
4. The sample is added with a hopper into the cup (Fig. 3)
5. The measuring head is placed in the starting position (Fig. 4)
6. The instrument starts automatically and mixes the sample
7. The software will automatically record and display the data

Fig. 1 Fig. 2 Fig. 3 Fig. 4

Measuring gluten strength: the GlutoPeak test

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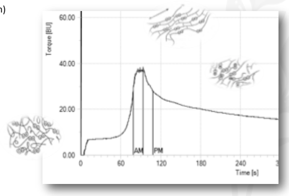

- After a time (dependent on the property of the sample), the gluten aggregates
- A uniform gluten network is formed, which results in a strong increase in torque
- Further mixing destroys the network, the torque decreases

Measuring gluten strength: the GlutoPeak test

It measures the **gluten aggregation** properties

- Rapid (<5 min)
- Small-scale (<10g)
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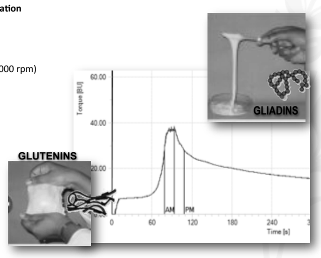
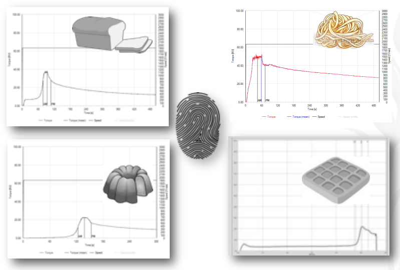


- *Maximum Torque is correlated to gliadin content (r=0.70; p<0.001; n=19)*
- *Aggregation time and Energy are correlated to glutenin (r=0.72; p<0.001) and GMP (r=0.77; p<0.001; n=19) content*

Martí et al. J Cereal Science 66, 89-95

Measuring gluten strength: the GlutoPeak test

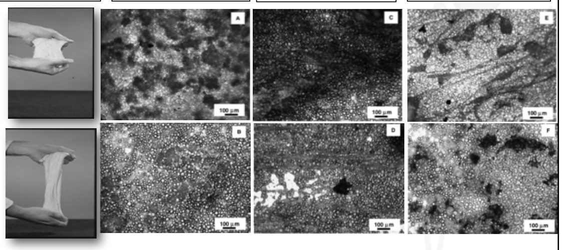


Measuring gluten strength: the GlutoPeak test

GLUTEN | BEFORE PEAK | @PEAK | AFTER PEAK

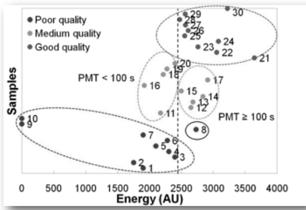
Good quality semolina

Poor quality semolina



Marti et al, Cereal Chem. 91, 542–547

Measuring gluten strength: the GlutoPeak test



Poor pasta-making performance: W<180 *10⁻⁴ J	Medium pasta-making performance: 180<W<250 *10⁻⁴ J	Good pasta-making performance: W>250 *10⁻⁴ J

N= 30 durum wheat varieties

Marti et al, Cereal Chem. 91, 542–547

Measuring gluten strength: the GlutoPeak test

Characterization of Durum Wheat Semolina by Means of a Rapid Shear-Based Method

Alessandra Marti,[1,2] Cristina Cecchini,[3] Maria Grazia D'Egidio,[3] Jens Dreisoerner,[4] and Maria Ambrogina Pagani[1]

ABSTRACT

Cereal Chem. 91(6):542–547

TABLE V
Correlation Coefficients of Pasta Quality Attributes and Rheological Indices[a]

Index	Stickiness All Samples (n = 30)	Stickiness 30 < GI < 65 (n = 9)	Firmness All Samples (n = 30)	Firmness 30 < GI < 65 (n = 9)	Bulkiness All Samples (n = 30)	Bulkiness 30 < GI < 65 (n = 9)	Overall Score All Samples (n = 30)	Overall Score 30 < GI < 65 (n = 9)
Gluten index	0.52***	ns	0.65***	ns	0.50***	ns	0.65***	ns
Maximum torque	0.55***	0.60**	ns	ns	0.42***	0.49*	0.38**	0.51*
Peak maximum time	ns	–0.66**	ns	ns	ns	–0.67***	ns	–0.59**
Energy	0.55***	ns	ns	ns	0.50***	ns	0.49***	ns
W alveographic	0.69***	ns	0.54***	0.55*	0.68***	ns	0.76***	ns

[a] GI = gluten index; *, **, and *** indicate $P < 0.1$, 0.05, and 0.01, respectively; and ns = not significant.

- N=30 samples
- LT drying

Measuring gluten strength: the GlutoPeak test

Partial Least Squares Regression (PLSR), n = 120

		H₂O GlutoPeak indices LVs	R^2_{CAL}	R^2_{CV}	R^2_{PRED}
Protein content (g/100 g)		3	0.87	0.85	0.90
Farinograph	Water absorption (%) (Far-Abs)	2	0.91	0.90	0.95
	Dough development time (min) (Far-Dev)	3	0.25	0.17	0.24
	Stability (min) (Far-Stab)	3	0.90	0.88	0.83
Alveograph	W (*10^{-4}J) (Alv-W)	2	0.83	0.81	0.75
	P/L (Alv-P/L)	2	0.43	0.37	0.33
	P (mmH_2O) (Alv-P)	3	0.82	0.80	0.87
	L (mm) (Alv-L)	1	0.05	–0.05	0.05
Extensograph 45 min	Energy (cm²) (Ext_45En)	2	0.77	0.74	0.79
	Resistance to extension (BU) (Ext_45Res)	3	0.47	0.41	0.41
	Extensibility (mm) (Ext_45Ext)	2	0.59	0.55	0.64
	Max resistance to extension (BU) (Ext_45Max)	2	0.76	0.73	0.78
	Ratio (Ext_45Rat)	3	0.07	–0.05	–0.17
	Ratio max (Ext_45RatMax)	3	0.49	0.42	0.52

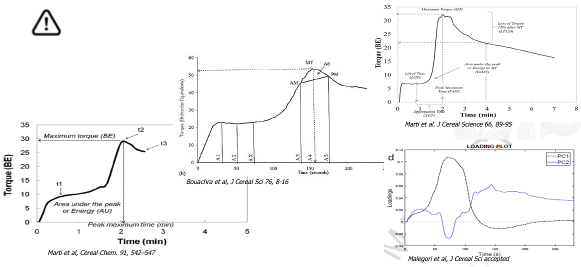
- *Maximum Torque is able to predict the protein content and farinograph water absorption*
- *Aggregation energy index is able to predict the conventional parameters related to dough mixing stability, tenacity, strength, and resistance to extension*

Marti et al, LWT 64, 95-103

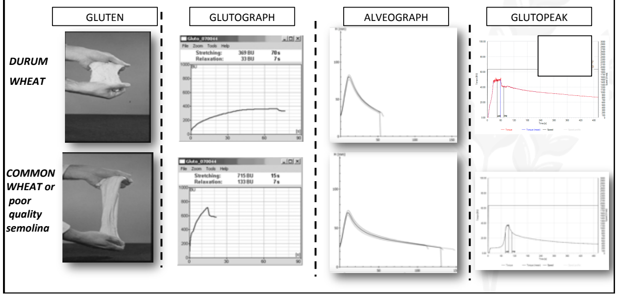
Measuring gluten strength: the GlutoPeak test

Flour	Solvent	Speed	Temperature	Reference
5.5 g gluten	12 ml water	3000 rpm	30°C	Int J Food Sci and Technol 45, 1641–1646
9.2 g	10.8 ml water	3000 rpm	30°C	Cereal Chem 88:253–259
10.9 g	9.1 ml water	3000 rpm	30°C	
8 g	10 ml water/salt solutions	2750 rpm	35°C	Food Research International 44, 893–896
8.5 g	9.5 ml 0.5M CaCl2	1900 rpm	34°C	J Food Quality 35, 68-75
9.4 g	8.6 ml water	2196 rpm	35°C	J Cereal Sci 56, 561-567
8 g	10 ml water	2750 rpm	35°C	
9 g	9 ml water	3000 rpm	35°C	J Food Quality 36, 133-138
8 g	10 ml water	3000 rpm	35°C	Cereal Chem. 91:318–320
9 g	10 ml water	2750 rpm	35°C	Cereal Chem. 91:542–547
8.5 g	9.5 ml 0.5M CaCl2	1900 rpm	34°C	J Cereal Sci 66, 89-95
9 g	10 ml water 10 ml 0.33 M NaCl	3000 rpm	35°C	LWT 64, 95-103
9 g	9 ml water	3000 rpm	36°C	Cereal Chem 93, 364-368
9 g	9 ml water	2750 rpm	36°C	Food Research Int 89, 330–337
9 g	10 ml water	2750 rpm	35°C	Cereal Chem 93, 650-556
8.5 g	9.5 ml 0.5M CaCl2	1900 rpm	34°C	Cereal Chem 94:199-204
8 g	10 ml water	2700 rpm	34°C	J Cereal Sci 76, 116-121
8.5 g	9.5 ml 0.5M CaCl2	1900 rpm	34°C	Cereal Chem 94:723-732

Measuring gluten strength: the GlutoPeak test



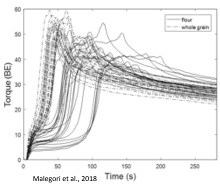
Measuring gluten strength



The role of raw materials

1980 Pasta from durum wheat semolina — 2000 Gluten-free pasta — 2015 Wholegrain pasta — Today Pre-cooked pasta

Weakening of gluten network



Malegori et al., 2018

The role of raw materials & processing

1980 Pasta from durum wheat semolina — 2000 Gluten-free pasta — 2015 Wholegrain pasta — Today Pre-cooked pasta

Weakening of gluten network

- Worsening of cooking quality

❑ Solutions:
- **Formulation:**
  - Using high quality semolina
  - Adding vital gluten
- **Processing:**
  - Pre-processing (debranning, air classification)
  - Kneading
  - Shaping

The role of processing: debranning

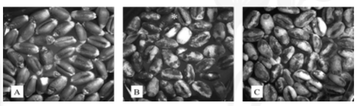
❑ Principle: Sequential and controlled removal of grain layers by abrasion (pearling)

❑ Advantages:
- Selective separation of the outer layers of the kernels which rich in bioactive compounds
- Addition of less quantity of material with the same content of bioactive compound


LWT - Food Science and Technology

Debranning of purple wheat: recovery of anthocyanin-rich fractions and their use in pasta production

Miriam Zanoletti, Parisa Abbasi Parizad, Vera Lavelli, Cristina Cecchini, Paolo Menesatti, Alessandra Marti, M. Ambrogina Pagani



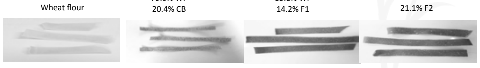
Stereo-microscope images of purple wheat kernel before A) and after the first B) or second C) debranning step

The role of processing: debranning

		Dietary Fiber Total (TDF)	Insoluble (IDF)	Soluble (SDF)	Anthocyanins (μg/g)	FRAP (μmol Fe(II)/g)
	Whole Purple Kernel	14.51 ± 0.09	12.5 ± 0.4 (86)	2.0 (14)	52.2 ± 0.4^d	4.2 ± 0.1^c
Conventional milling	Flour	3.69 ± 0.08^g	1.05 ± 0.04^f (29)	2.6 (71)	n.d.	0.45 ± 0.05^f
	Bran →	43.5 ± 0.4^b	41.86 ± 0.02^b (96)	1.7 (4) →	295 ± 7^b	12.7 ± 0.2^b
	Middlings	7.58 ± 0.03^f	5.48 ± 0.03^e (72)	2.1 (28)	9.1 ± 0.3^e	2.09 ± 0.02^{cd}
Debranning	Fraction 1 →	62.6 ± 0.3^a	60.1 ± 0.4^a (96)	2.5 (4) →	695 ± 64^a	25 ± 1^a
	Fraction 2	42.1 ± 0.8^c	39.6 ± 0.8^c (94)	2.5 (6)	295 ± 21^b	26 ± 3^a
Milling after debranning	Flour	2.70 ± 0.06^h	0.89 ± 0.06^f (33)	1.8 (67)	n.d.	0.25 ± 0.01^f
	Bran	33.9 ± 0.2^d	27.4 ± 0.2^d (81)	6.5 (19)	93 ± 3^c	13 ± 3^b
	Middlings	9.51 ± 0.07^e	4.93 ± 0.02^e (52)	4.6 (48)	11.9 ± 0.4^e	2.5 ± 0.2^{cd}

P-CF 100% Wheat flour — P-CB 79.6% WF 20.4% CB — P-F1 85.8% WF 14.2% F1 — P-F2 80.0% WF 21.1% F2

Fiber content 8.5%



Formulation of enriched pasta in bran (P-CB) or in debranning fractions (P-F1; P-F2).

The role of processing: debranning

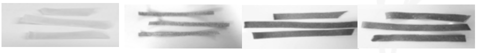
Table 4
Pasta cooking properties: optimal cooking time, water absorption, cooking loss, antioxidant capacity (expressed as FRAP) and anthocyanins content of cooked pasta. P-C, control pasta from refined wheat flour; P-CB, CB-enriched wheat pasta; P-F1, F1-enriched wheat pasta; P-F2, F2-enriched wheat pasta.

	P-C	P-CB	P-F1	P-F2
Optimal cooking time (min)	4	4	4	4
Water absorption (g/100 g)	128.6 ± 0.8[a]	105 ± 11[b]	110 ± 2[b]	127 ± 1[a]
Cooking loss (g/100 g)	2.5 ± 0.4[b]	2.8 ± 0.1[ab]	3.2 ± 0.3[a]	3.18 ± 0.03[a]
FRAP (μmol Fe(II)/g)	n.d.	2.41 ± 0.06[ab]	2.6 ± 0.1[a]	2.3 ± 0.2[b]
Anthocyanins (μg/g)	n.d.	28 ± 2[b]	67.9 ± 0.9[a]	60 ± 1[a]

Mean ± SD (Water absorption and cooking loss: n = 5; FRAP and Anthocyanins: n = 4 from two independent extractions).
Different letters in the same row indicate statistically significant differences (LSD; $p \leq 0.05$).
n.d. = not determined.

P-CF	P-CB	P-F1	P-F2
100% Wheat flour	79.6% WF 20.4% CB	85.8% WF 14.2% F1	80.0% WF 21.1% F2

Fiber content 8.5%



Formulation of enriched pasta in bran (P-CB) or in debranning fractions (P-F1; P-F2).

The role of processing: air-classification

Figure from Poutanen, 2012, Trends in Food Science & Technology 25, 58-62


Journal of Cereal Science

Optimization of air classification for the production of β-glucan-enriched barley flours

- Principle: The combination of air currents with centrifugal force can separate flour particles into different fractions according to size and density
- Advantages:
  - To obtain fractions with higher contents of compounds of interest.
  - Addition of less quantity of material with the same content of bioactive compound

Table 1
Main components of barley flours.

Genotype	Flour fraction	Yield (%)	Protein (%)*	Starch (%)*	TDF (%)*	β-Glucans (%)*
CDC Alamo	Micronized	–	12.6[e]	53.2[d]	12.8[d]	7.8[c]
	CF1	10.4	14.0[c]	42.8[h]	25.5[a]	11.1[b]
	CF2	28.4	13.6[d]	43.[illegible]	25.5[a]	15.6[a]
	FF2	61.2	12.6[e]	61.[illegible]	3.8[f]	2.3[e]
Priora	Micronized	–	13.7[d]	55.3[c]	11.5[e]	5.4[d]
	CF1	16.5	15.6[a]	51.1[e]	23.4[b]	8.1[c]
	CF2	29.8	14.4[b]	46.4[f]	21.8[c]	11.2[b]
	FF2	53.7	12.4[e]	66.7[a]	3.3[g]	3.0[e]

CF1 and CF2 are the coarse fractions from the first and second air classification, respectively; FF2 is the fine fraction from the second air classification (see Fig. 2). ANOVA showed a significant effect of genotype and flour fraction as well as their interaction on each component ($p < 0.001$).
* Values followed by the same letter are not significantly different ($p < 0.05$; Tukey test).

The role of raw materials & processing

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Weakening of gluten network

- Worsening of cooking quality

- **Solutions:**
  - **Formulation:**
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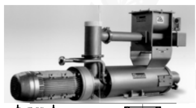
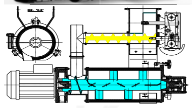
    - Adding vital gluten
  - **Processing:**
    - Pre-processing (debranning, air classification)
    - Kneading
    - Shaping

The role of processing: kneading

PREMIX

- Aim:
  - Dosing the raw materials
  - Water distribution
  - Protein hydration
- Issues:
  - Competition of fiber and proteins for water
- Solutions:
  - Homogenous water distribution within the flour





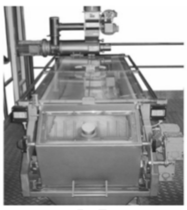
Storci PASTA MACHINERY

The role of processing: kneading

BELTMIX

- Aim:
  - Dosing the raw materials
  - Water distribution
  - Protein hydration
- Issues:
  - Competition of fiber and proteins for water
- Solutions:
  - Homogenous water distribution within the flour
  - Water distribution towards unhydrated semolina particles

Advantages
- No mechanical action: limited oxidation to the top layer
- No dirty materials in the system
- Easy to clean



FAVA impianti per pastifici

The role of raw materials & processing

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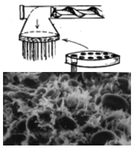
    - Shaping

The role of processing: shaping

- Aim:
  - (Partial) gluten development
  - Formation of an homogeneous mixture
  - Shaping the product
- Issues:
  - Weakening of gluten network by fiber
- Solutions:
  - alignment of protein fibrils

Semolina
Water → KNEADING → SHAPING → DRYING (4 24 hours and more; HT cycles: till 90°C; LT cycles:50-55°C) → Dried Pasta

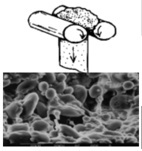
Extrusion



HIGH PRODUCTIVITY (1000÷10000 kg/h)

30 % H_2O
2 ÷ 3 min
45 ÷ 55° C
90 ÷ 120 atm
9 ÷ 12 MPa

Sheeting



LOW PRODUCTIVITY (100÷1000 kg/h)

32 ÷ 33 % H_2O; 5 ÷ 20 min; 20 ÷ 30° C
No over pressure
(but in the contact point of rolls)

The role of processing: shaping

- Aim:
  - (Partial) gluten development
  - Formation of an homogeneous mixture
  - Shaping the product
- Issues:
  - Weakening of gluten network by fiber
- Solutions:
  - alignment of protein fibrils

International Journal of Food Science & Technology
International Journal of Food Science and Technology 2011, **46**, 2393–2400

Original article
Quality characteristics of dried pasta enriched with buckwheat flour

Alessandra Marti, Lorenzo Fongaro, Micaela Rossi, Mara Lucisano & Maria Ambrogina Pagani*
DiSTAM, Università degli Studi di Milano, via G. Celoria 2, 20133 Milan, Italy

Table 3 Cooking and textural properties of *Pizzoccheri* samples

				Before cooking		After cooking	
Pizzoccheri	Optimal cooking time (min)	Water absorption (%)	Solid content of cooking water (g/100 g)	Stress (N/mm^2)	Strain	Young Modulus (N/mm^2)	Adhesiveness (J)
Sample A	12	97c	5.0b	17.57a	3.76a	0.48a	7.09b
Sample B	10	91a	4.3a	22.28b	6.15b	0.58b	5.49a
Sample C	15	89b	4.6ab	43.91c	6.05b	0.58b	7.38b

Means followed by different letters in a column are significantly different at $P < 0.05$.

- sample A: extrusion
- sample B: sheeting
- sample C: extrusion + sheeting

Take home points

- Pasta cooking quality is defined by both the characteristics of the raw materials and the processing conditions.
- Some processing conditions (e.g. HT drying) can improve the cooking quality of pasta made from raw materials with poor technological quality but they can not delete the differences among semolina samples with different pasta-making aptitude.
- While formulating healthy cereal based products, industries need to balance nutritional value (i.e. fiber-enrichment level) with product quality.
- Non conventional raw-materials can be used but balanced formulation (high protein semolina), peculiar pre-processing (debranning) and pasta-making conditions (sheeting, LT drying) are needed to counteract their poor technological properties.

Gracias!

31 Jornadas Técnicas
Asociación Española de Técnicos Cerealistas
Zaragoza 2019

aetc.es

Organizan:

Patrocinador PLATINO:

Patrocinadores ORO:

Patrocinadores PLATA: