CHOPIN TECHNOLOGIES

Tortilla Wheat Flour characteristics and quality

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KPM ANALYTICS

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CHOPIN TECHNOLOGIES

Who are we?

KPM ANALYTICS

PROCESS SENSORS CORPORATION

Unity Scientific

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AMS Alliance

NIR process moisture measurement	NIR offline analyzers	Methods and equipment for the analysis of characteristics of cereals and derivatives	Instrumentation, reagents and tests

• Animal food
• Paper converting
• Chemicals & Pharmaceuticals
• Human food
• Tobacco
• Wood
• Minerals
• Textiles
• Renewable energy
	• Agricultural
	  • Feed ingredients
	  • Compound feed
	  • Pet food
	  • Oilseeds
	  • Forage
	• Food and Dairy
	• Environmental & Industrial
	  • Water
	  • Soils
		• Sample preparation
		• Compositional analysis
		• Functional analysis
		• Bin temperature monitoring
			• Medical diagnostics
			• Environment
			• Food & beverage industries

Our Customers

CHOPIN Technologies customers come from across the cereal chain, from seed to finished product

- Breeders
- Traders
- Elevators
- Primary processing industries
  - Milling and malting
- Manufacturers of ingredients or additives for flour
- Baking industries, secondary processors
  - Bakers
  - Pasta producers
  - Snack producers
- Laboratories, Research Institutes, Universities

CHOPIN Technologies DNA: Innovation

Mixolab

Measures the characteristics of dough during mixing, heating and cooling determining the quality of starch and protein

Quatuor II

Automatic dockage tester for determination of seed impurities

Aquaneo

Moisture meters for the certified measurement of the moisture content of cereals and oilseeds

Mixolab 2

New generation of Mixolab

Alveolab

New generation of Alveograph, full version

AlveoPC

New generation of Alveograph, basic version

SRC CHOPIN

Automated measurement of the solvent retention capacity

2003 | 2005 | 2007 | 2009 | 2010 | 2011 | 2013 | 2014 | *2016* | 2017 | 2018

SDmatic

Analyzer of damaged starch in less than 10 minutes

Infraneo

Infrared analyzer for whole grains and powdery products

Infraneo JR

Infrared analyzer with a smaller capacity for whole grains and powdery products

RheoF4

Unique solution to analyze dough proofing properties

LabMill

Reproduces industrial mill productivity. Analyzes soft and hard wheat milling capacity

AmyLab FN

Faster method for prediction of Hagberg falling number value

Spectralab

High performance NIR analyzer designed for process control in flour mills

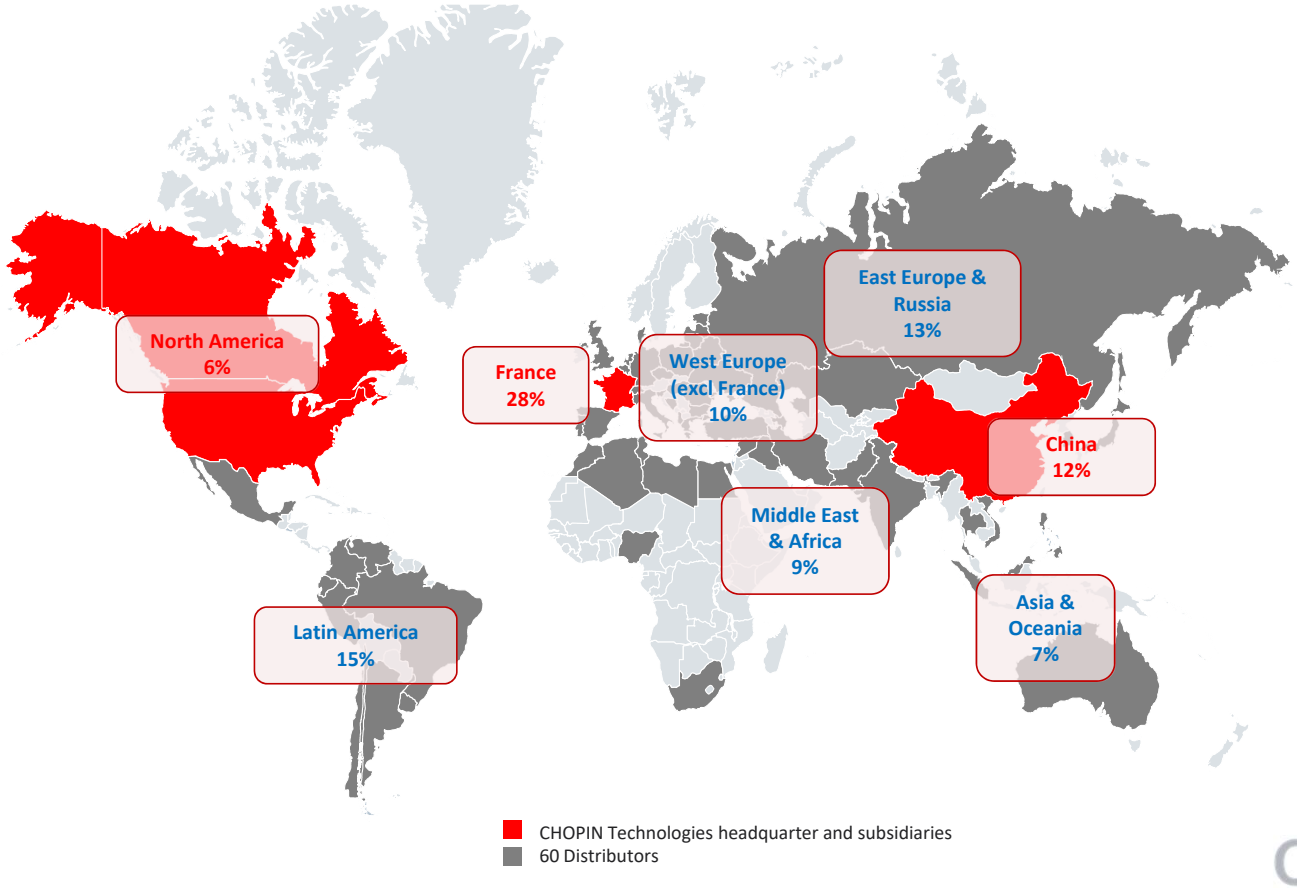
Quality: Our Priority

- CHOPIN Technologies operates a Quality Management System which complies with the requirements of ISO 9001 : 2015 standard.

- CHOPIN Technologies manufactures high quality equipment, recognized by numerous international organizations.

- CHOPIN Technologies takes part, as an expert, in different standardization groups.

Global presence, both direct and through distributors



Let's talk about Tortillas and Quality

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Method
Basis of the work supporting this presentation

- 1/ Our experience on flour quality and how to measure it
- 2/ Analysis of previous TIA Technical Conferences presentations
  - Steve Bright: 2017 (2), 2015 (2) & 2016
  - Cristina Primo Martin: (2017)
  - Tom Jondiko: (2016)
  - Dilek Austin: (2016)

Main flour quality - related identified control point

- Tortilla Size and Shape
- Rollability/Foldability/Flexibility
- Appearance for users
  - Cracks
  - Edges
  - Pillowing
  - Texture
- Stickiness
- Shelf Life

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Tortilla Size and Shape

Tortilla too small

- Strong flour : Elastic
- Under mixed : Elastic
- Underhydrated : Elastic
- (Cold dough, under scaling, excessive floor time after mixing, poor press setup, oven shrinkage)

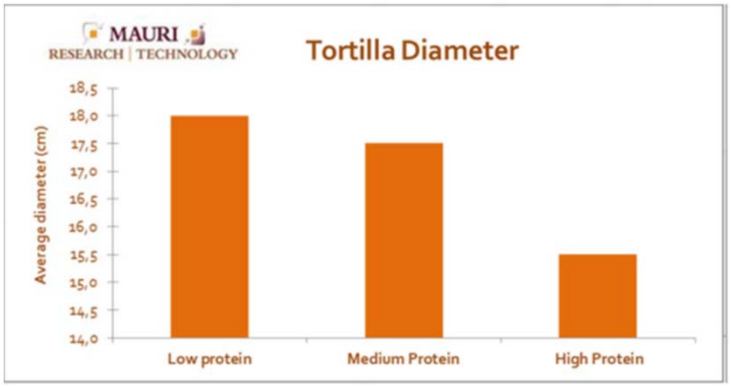
Tortilla too large

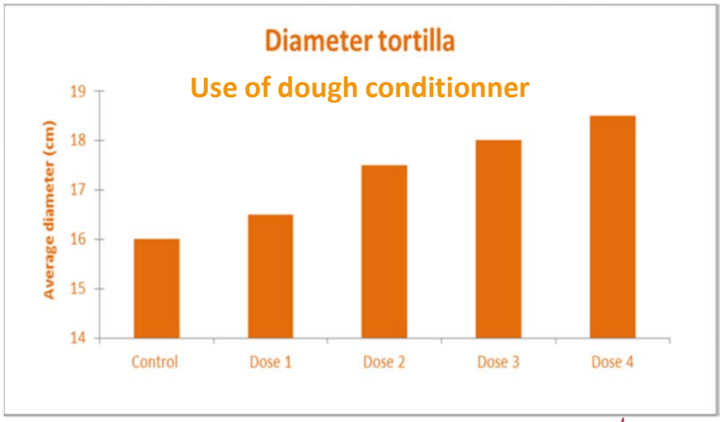
- Overly extensible flour
- Flour quality
- Protein quantity/quality
- Overhydration
- (Over mixing, hot dough, high level of reducing agents, press too severe, high fat level, over scaling)

Source : Steve Bright TIA technical conference 2015

Tortilla Size and Shape

- Importance of Gluten Quality
  - Strong flour tend to produce tortillas with smaller diameter
  - Weak flour can give;
    - Thinner tortilla, less gaz retention
    - Severe Sticking
    - Fragile Tortilla, poor shelf stability
    - Poor shape (too large)





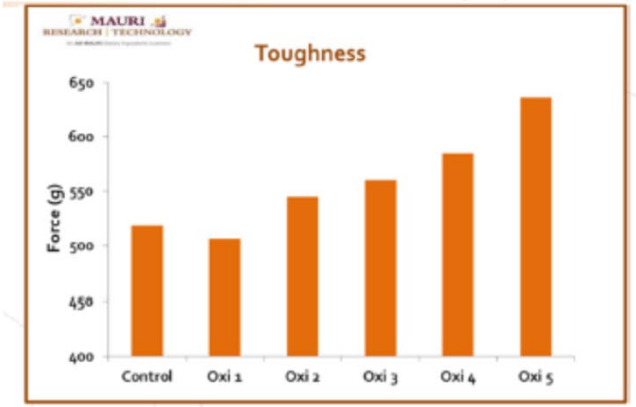
Sources : Steve Bright TIA technical conference 2015
Cristina Primo Martin TIA technical conference 2017

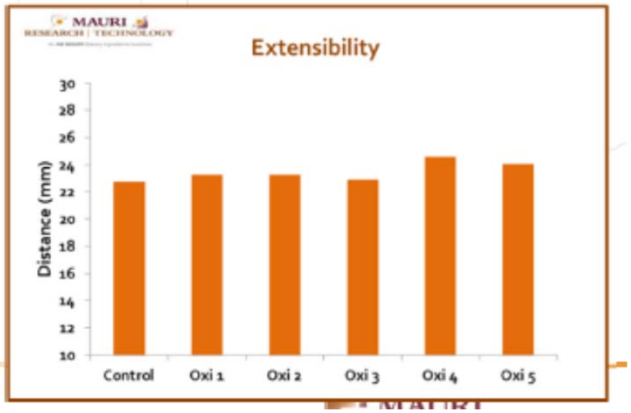
Tortilla Size and Shape

- By modifying gluten properties, proteases or oxydases are enzymes that help control Tortilla diameter.

40 ppm L-Cysteine

Tortilla dough conditioner



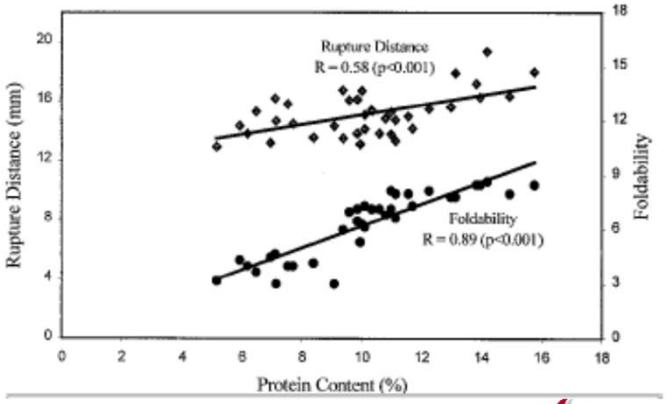


Sources : Cristina Primo Martin TIA technical conference 2017

Rollability/Foldability/Flexibility

- Protein is important…

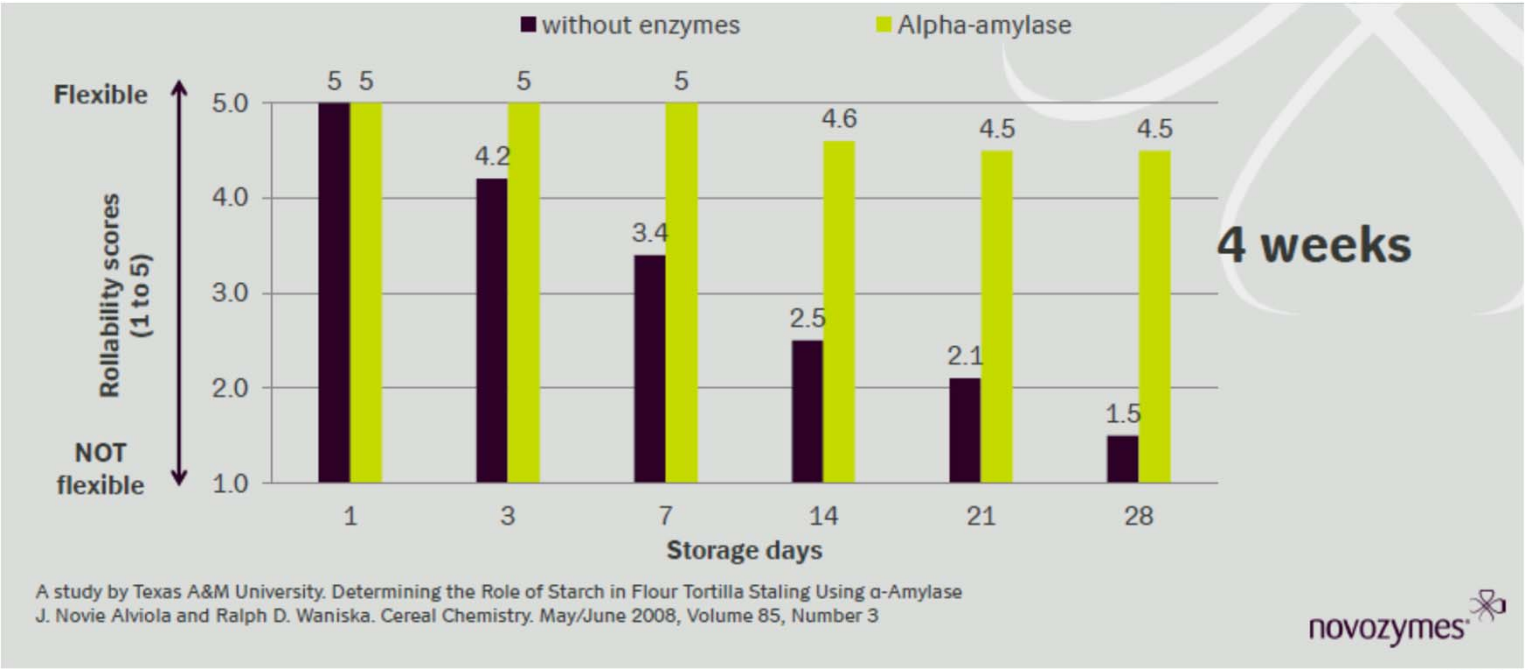
- Low Protein Content (<9%)
  - Tortilla cracks easily
  - Larger diameters
- Protein content >12%
  - Better foldability
  - But too long mixing & resting time
  - Smaller diameters



Sources : Cristina Primo Martin TIA technical conference 2017

Rollability/Foldability/Flexibility

- …and Starch is also playing a major role



Sources : Dilek Austin TIA technical conference 2016

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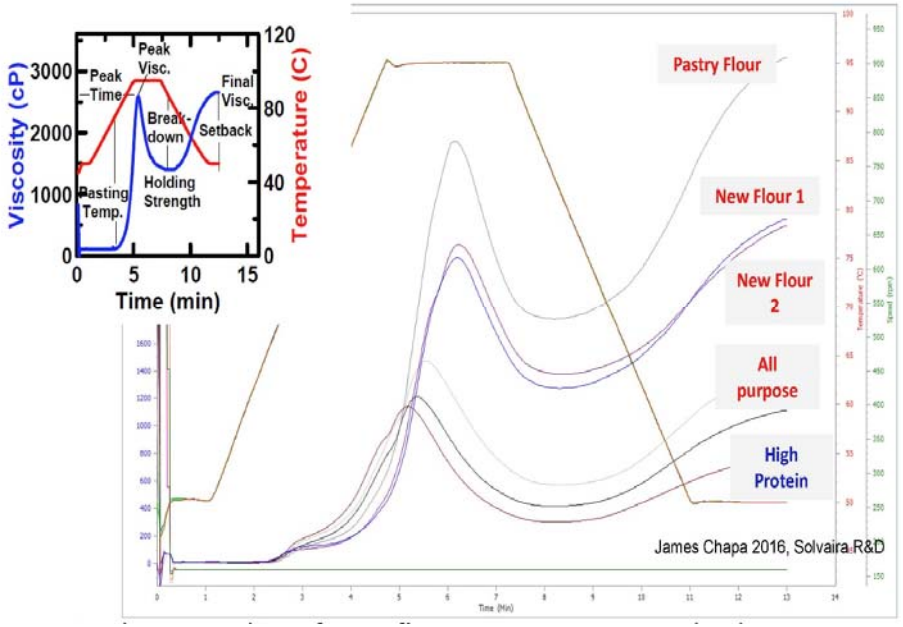
Rollability/Foldability/Flexibility

- …as well as starch quality and damage



Flour: Starch Quality

- Good quality tortillas produced using wheat flour of intermediate protein and low level of starch damage (Waniska et al 2004).

Starch characteristics:

- Measured using rapid visco analyzer.
- Peak and final viscosity.
- Affect cooking conditions.
- Tortilla flexibility.
- Tortilla shelf stability.

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Sources : Cristina Primo Martin TIA technical conference 2017

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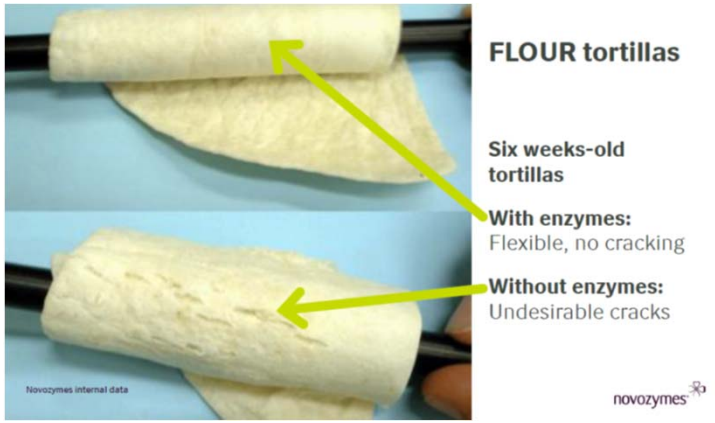
Appearance for users

CRACKS

- Low protein content (< 9%):
  - gives tortillas that crack easily,



*Enzyme : amylase

EDGES

Reducing agents

Used to aid pressing the dough to a desired size
- L-Cysteine
- Sodium metabisulfite
- Inactive yeast

Low use rates (ppm) cost effective.

Under use
- Small sizes
- Brittle, rough edges
- Laced edges
- $$$ Cost in rejects

Sources : Cristina Primo Martin TIA technical conference 2017
Dilek Austin TIA Technical Conference 2016
Steve Bright TIA Technical conference 2017

Appearance for users

PILLOWING

Strong Flour
enhances pillowing
gas retention

TEXTURE

- Texture properties can be affected by modifying starch structure: A limited starch breakdown is needed to give the tortillas the required strength and eating properties (bite, chewiness)

Mouthfeel, bite

✓Short tender bite
Established by formula and process
Lamination
From leavening
Not over pressed –pressure, dwell time, temperature

X Leathery, tough bite
High translucency
Insufficient leavening
Hot press
Extended press dwell times

Sources : Steve Bright TIA Technical conference 2015
Cristina Primo Martin TIA technical conference 2017

Stickiness

- Dough Stickiness
  - Starch Damage, Protein quality

Damaged starch: starch granules can be damaged during milling. They have a very high water absorption that can lead to stickiness and quality problems.

- Tortilla stickiness
  - Protein quality
  - Formulation (fat, sugar…)

Sticking - Reducing Agents

L-Cysteine and sodium metbisulfite
- greater extensibility in the dough
- higher levels (>60ppm) lead to weak protein and crust resilience.
- Increases the occurrence of sticking

•Obtain dough consistency through
- full mix development
- Optimizing flour to water ratio

Sources : Cristina Primo Martin TIA technical conference 2017
Steve Bright TIA Technical conference 2015

Shelf Life

Wheat Flour - Starch

Changes occurring in the starch during baking affect their functionality:

- After gelatinization starch tends to regain crystalline structure: Retrogradation
- Negative effect on shelf life (staling): Fresh tortillas have good foldability but during storage, tortillas get harder and loss foldability.
  - Amylose retrogradates fast after baking (≈ 30-60 min)
  - Amylopectin retrogradation starts one day after baking

Preservative / Shelf Life Extenders

PRESERVATIVES - Low use rate
- Short shelf life
- Moldy tortillas

Gums

Added for shelf life extension and anti-sticking
- Many types of gums available
  - Guar, Cellulose, Xanthan

Emulsifiers

Added for shelf life extension and anti-sticking
- Many types of emulsifiers available
  - Monoglycerides, SSL, DATEM, Lecithin

Insufficient gluten (in flour and added as an ingredient)
- Thinner tortillas, less gas retention
- Severe sticking
- Fragile tortillas, poor shelf stability. No elasticity in the finished tortilla
- Poor shapes in the press, excessive sizes

Sources : Steve Bright TIA Technical conference 2015
Cristina Primo Martin TIA technical conference 2017

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Summary
Flour-related main control points

	Protein	Starch	Water
Size & shape	++++ (extensibility/Elasticity)		++ (Overhydration)
Rollability	+++ (Protein content…and quality)	++++ (Properties improved with Amylase action) +++ (Starch damage)	
Appearance	++++ (Cracks, Edges, Pillowing, Texture)	+++ (Cracks, texture)	++ (Pillowing)
Stickiness	++++ (Protein content…and quality)	+++ (Starch properties)	++ (Overhydration)
Shelf Life	++++ (Protein content…and quality)	+++ (Starch Properties) +++ (Starch damage)	

Main flour component impacting Flour quality for Tortilla Production

- PROTEIN
  - Content, Strength, Elasticity, Extensibility
- STARCH
  - Properties (viscosity, retrogradation), starch damage
- HYDRATION
  - Protein content, starch damage
- FORMULA
  - How to test complete formula, can we test dough from the processing line?

Best potential tools

Infraneo

SDmatic

Alveograph

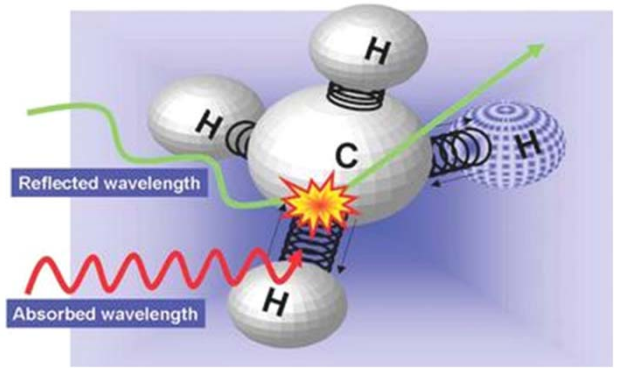
Mixolab

Tortilla flour quality

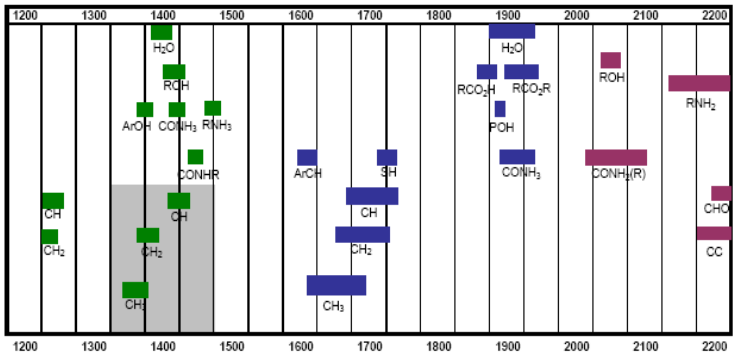
Quantitative Analysis: NIRS

Reminder on NIR basics (1/2)

- NIR has many advantages :
  - Simplicity
  - Speed
  - Clean
  - Performances…



- But keep in mind theses devices are measuring some light wavelength absorbed that depends on the vibration properties of some known chemical linkages (ex : NH for the protein).



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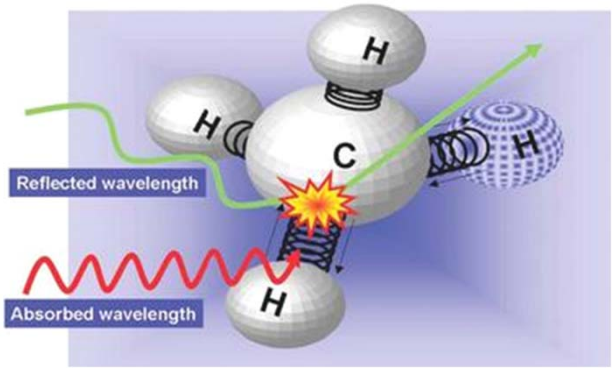
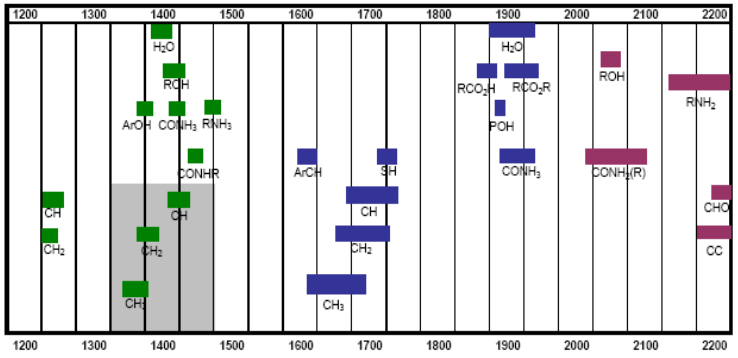
Reminder on NIR basics (2/2)

- The absorption peaks are mathematically analysed according to the sample concentration for the requested element to analyse (ex : proteins)

- Important consequences:
  - The infrared method relies on the accuracy of the reference method which is mirrored
  - The more a parameter or a component is far for the regular NIR conditions, the more its estimation becomes difficult. The calibration developed for such components are giving « trends » results and can't be that accurate.





NIRS for Flour

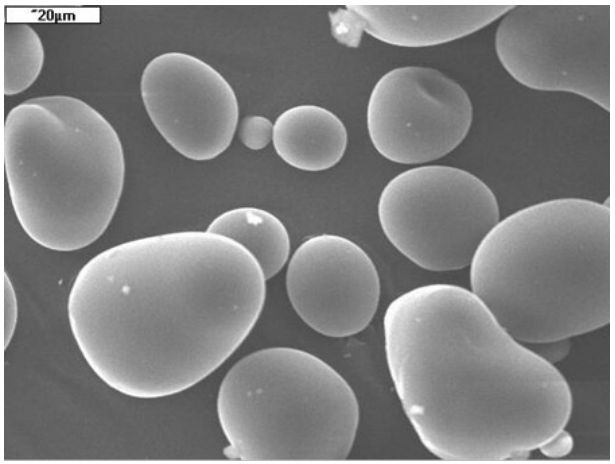
	Specific absorption peaks ?	Relations with a component with a dedicated peak ?	Comments
Moisture	**Yes (many)**	**No**	**Measurement**
Proteins	**Yes (many)**	**No**	**Measurement**
Wet Gluten	**No**	**Direct (proteins)**	**Measurement**
Water absorption capacity	**No**	**Indirect (Proteins, starch)**	**Estimation**
Ashes	**No**	**indirecte (relation with Cellulose)**	**Estimation**
Starch	**Yes**	**No**	**Measurement**

BEWARE of « calibrations » not based on sound science, these can be strongly misleading (Alveograph, bread volume… data for example)

Measuring Starch Damage

1. Introduction - starch

- Starch is semi crystalline structure composed of two polymers : amylose and amylopectin
  - The grain kernel contains 65-70% starch
  - Starch is the main element of flour; from 68 to 72%



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2. Starch Damage

- During milling, the starch granules are more or less damaged depending on:
  - **Wheat hardness (genetic criteria)**
  - **Milling adjustments , including wheat tempering (mechanical criteria)**

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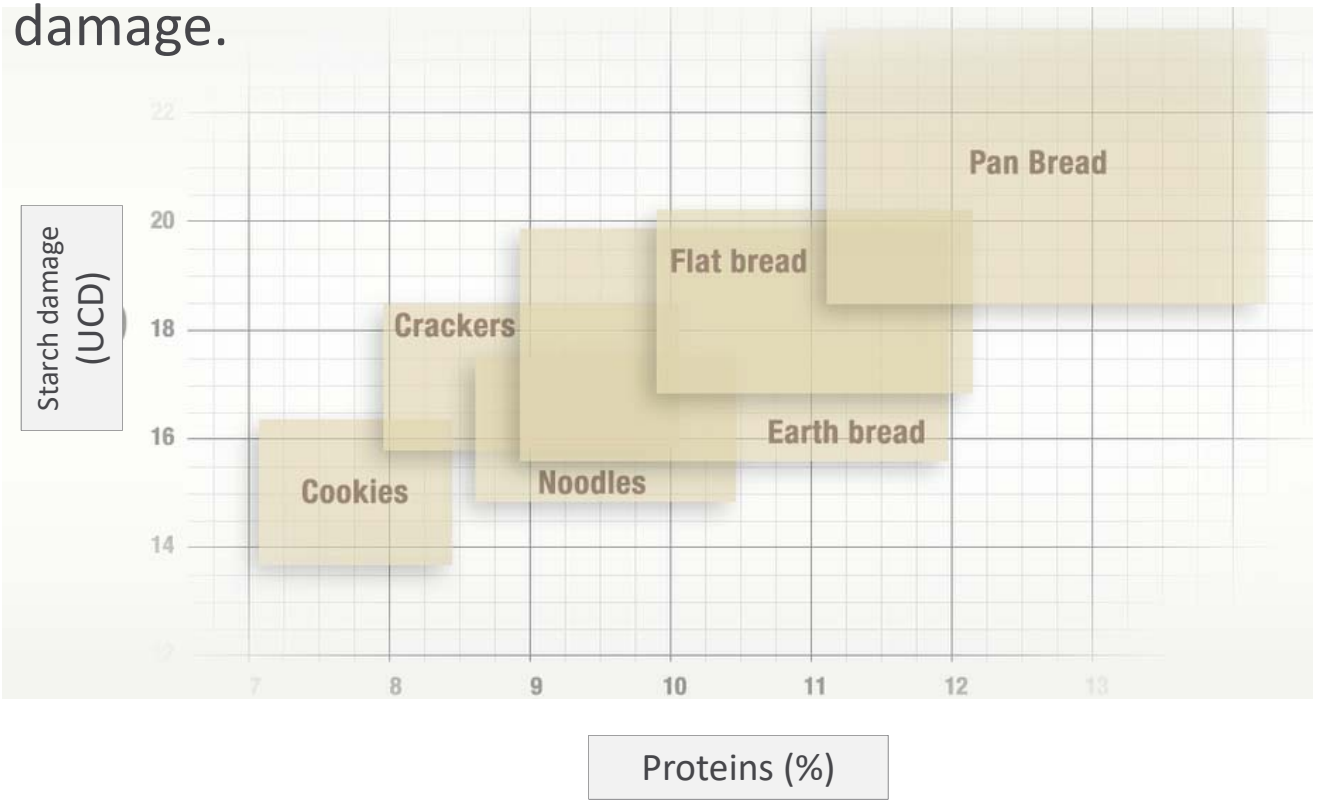
3. Why measure starch damage?

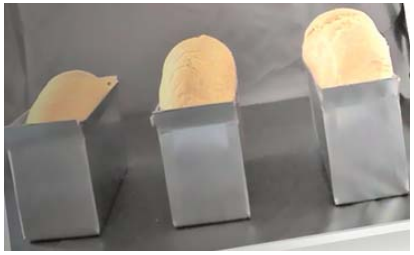
- For any product, there is an optimum level of starch damage.



3. Why measure starch damage?

- A lack of control of starch damage may lead to several issues during product manufacturing.

Stickiness



Fermentation

Texture

Color

Cracks

3.1 Effects on water absorption

- Protein absorbs 1.8 times its weight of water.
- Pentosans :10 times
- Native starch : 0.4 times
- Damaged starch: 3 to 4 times

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3.2 Effects on biscuits cracks

- An excess of starch damage causes:
  - Broken biscuits when packaging is opened!
  - Biscuit with colour defaults (too dark / too light)
  - Non standard size

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Dough Rheology : The Alveolab

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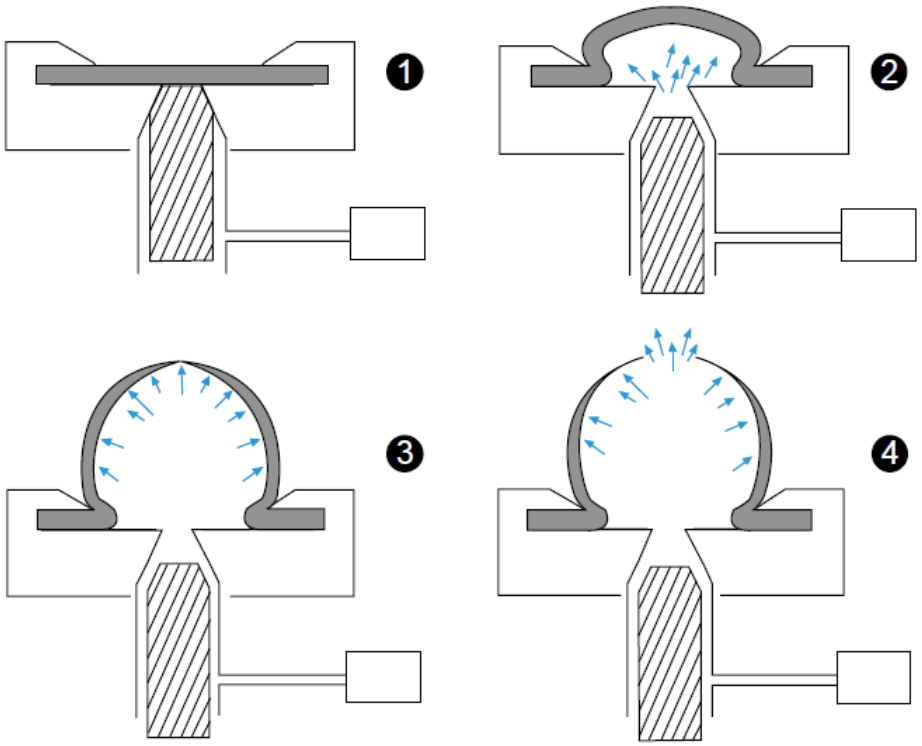
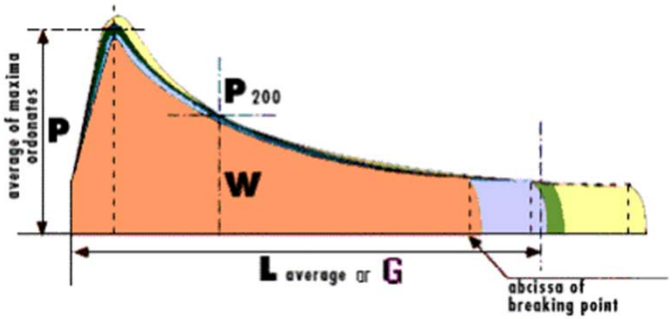
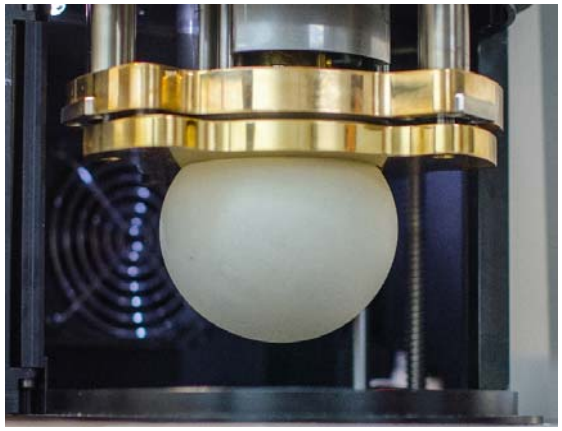
The Alveograph is all about Bubble!



- 1- system in position
- 2- blowing starts
- 3- expansion
- 4- until bubble bursts





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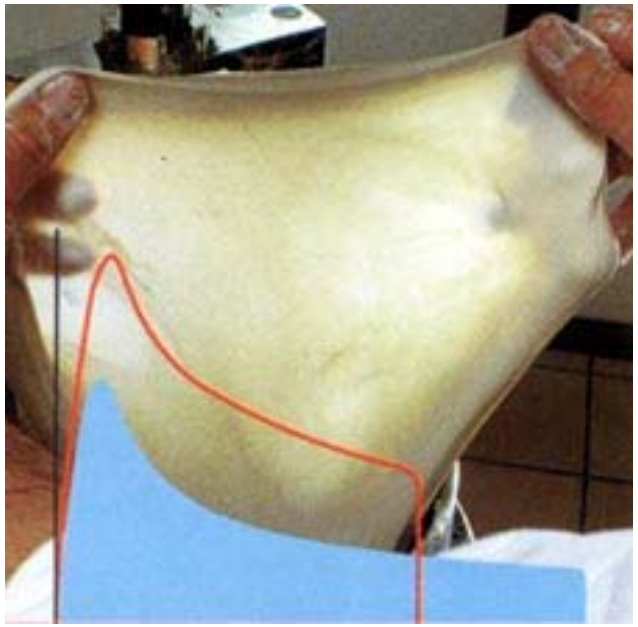
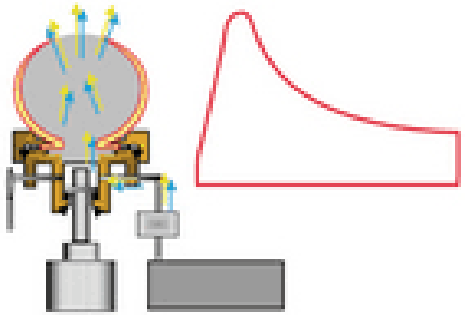
Flour Strength (W)





Baking strength depends on :

-Protein quality and quantity
-Starch damage
- Enzymatic activity
-And more

-It is a « global view » it is always better to work on P, G and Ie.

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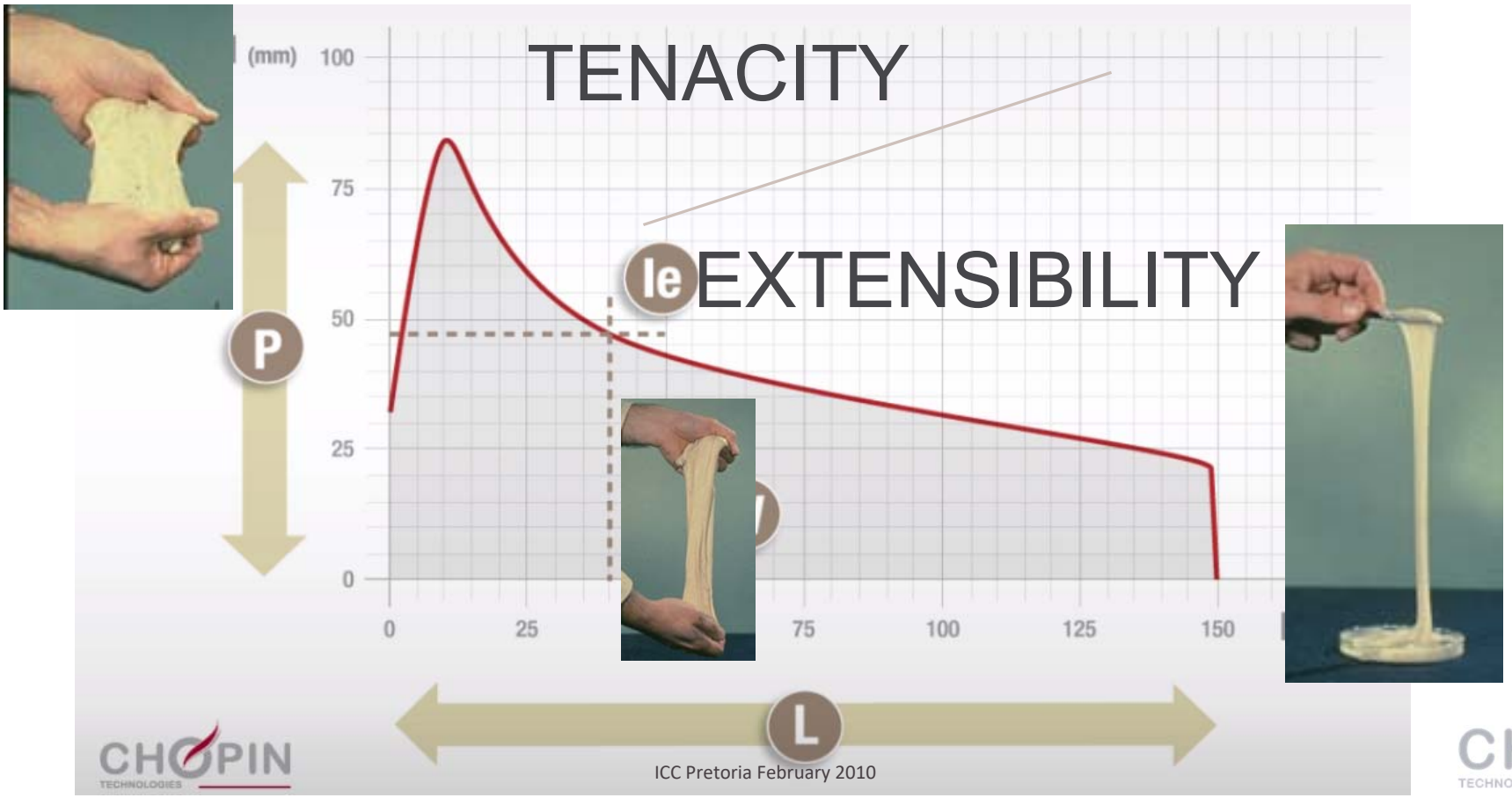
Strength is composed of different aspects



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Elasticity (Ie)

- Elasticity is the hability of a dough to return to its original state when the stress disappears.
- It is measured on the alveograph 40 mm after the test beginning.
- At this time, trhe instrument has injected 200 ml of air inside the bubble.
- The volume of the bubble at this very moment indicates dough resistance to deformation which is a measure of elasticity

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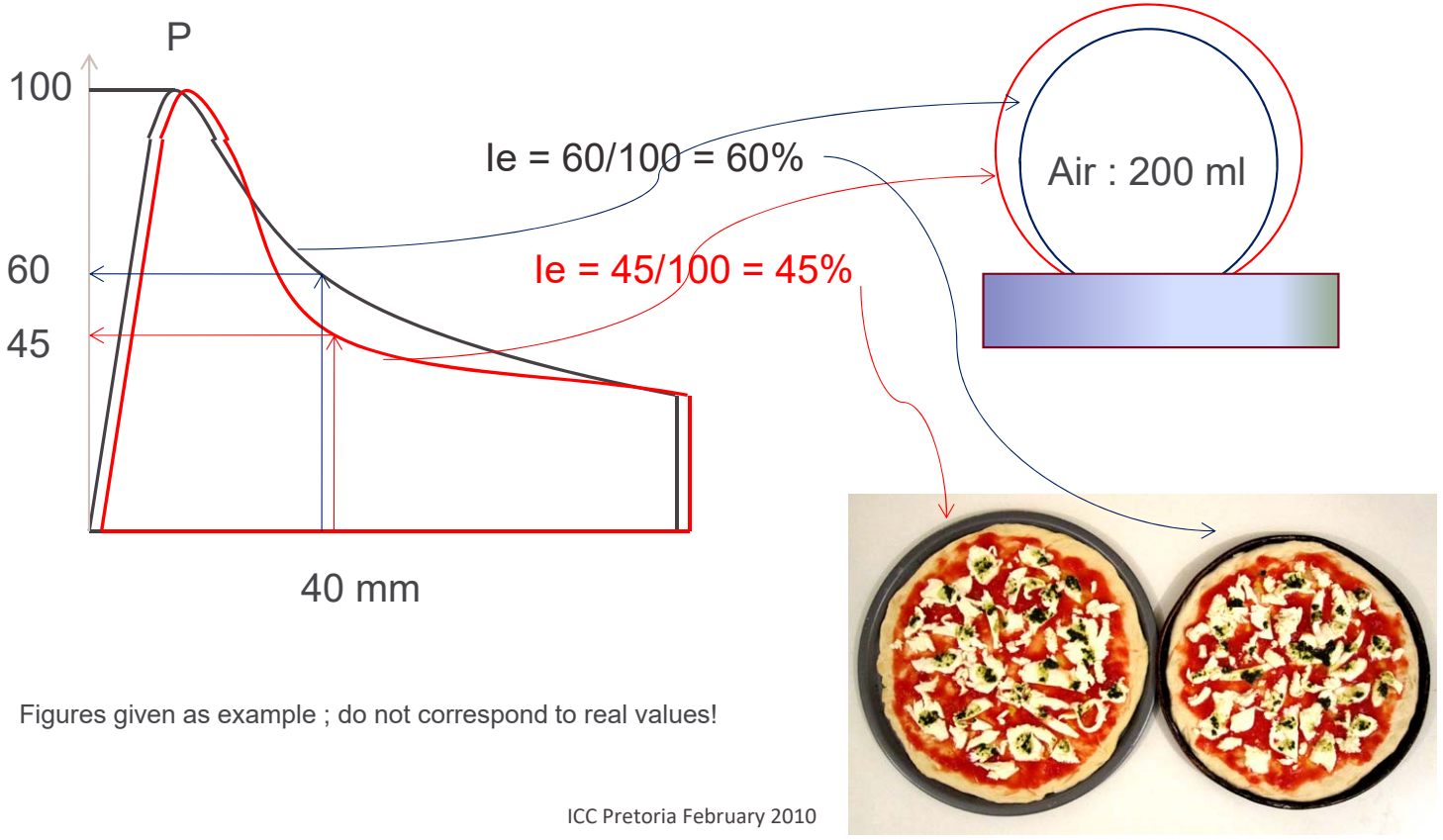
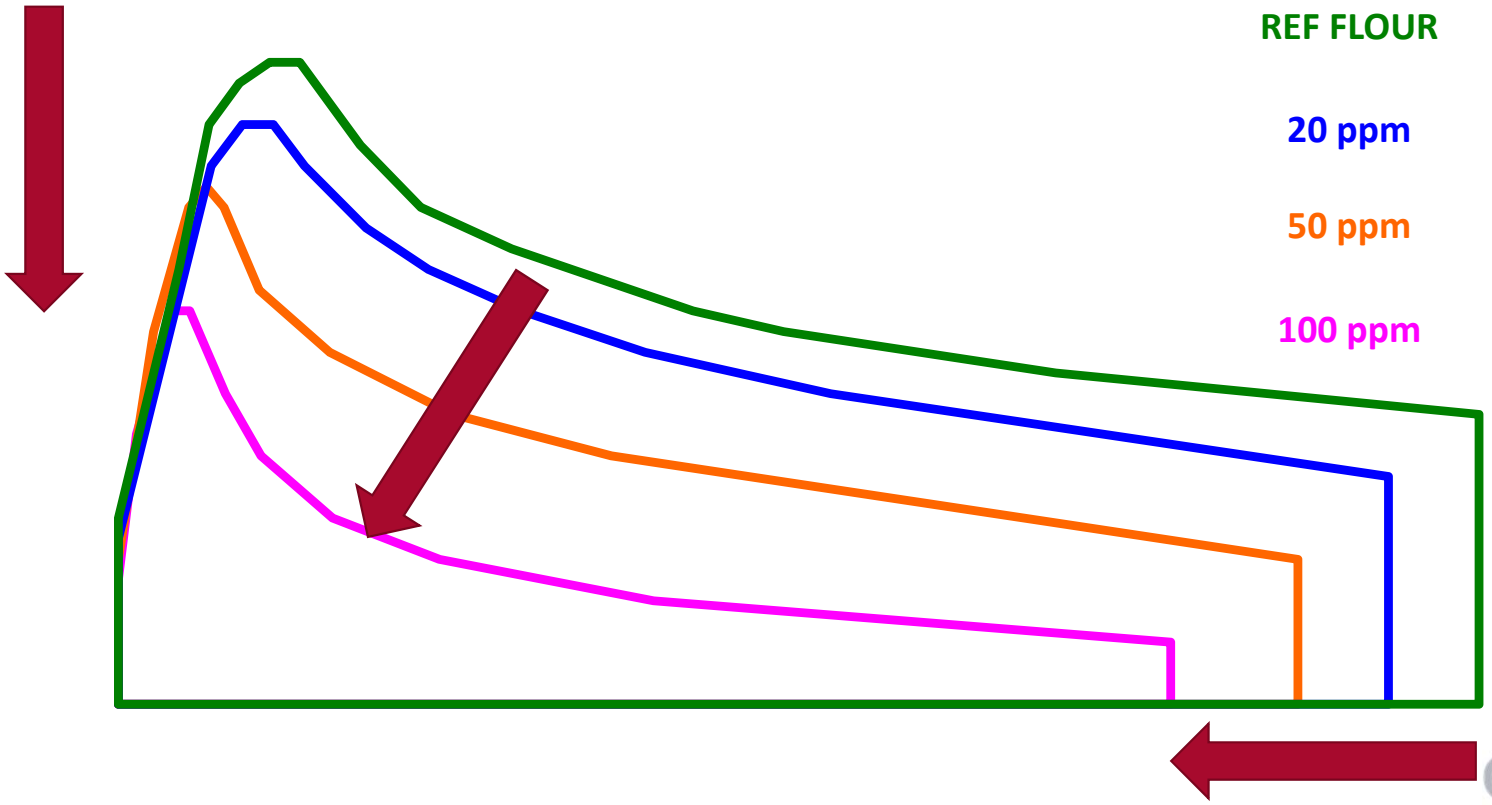
Focus on elasticity measurement



Figures given as example ; do not correspond to real values!

Processing aids action : example on Cysteine



Dough Rheology: The Mixolab

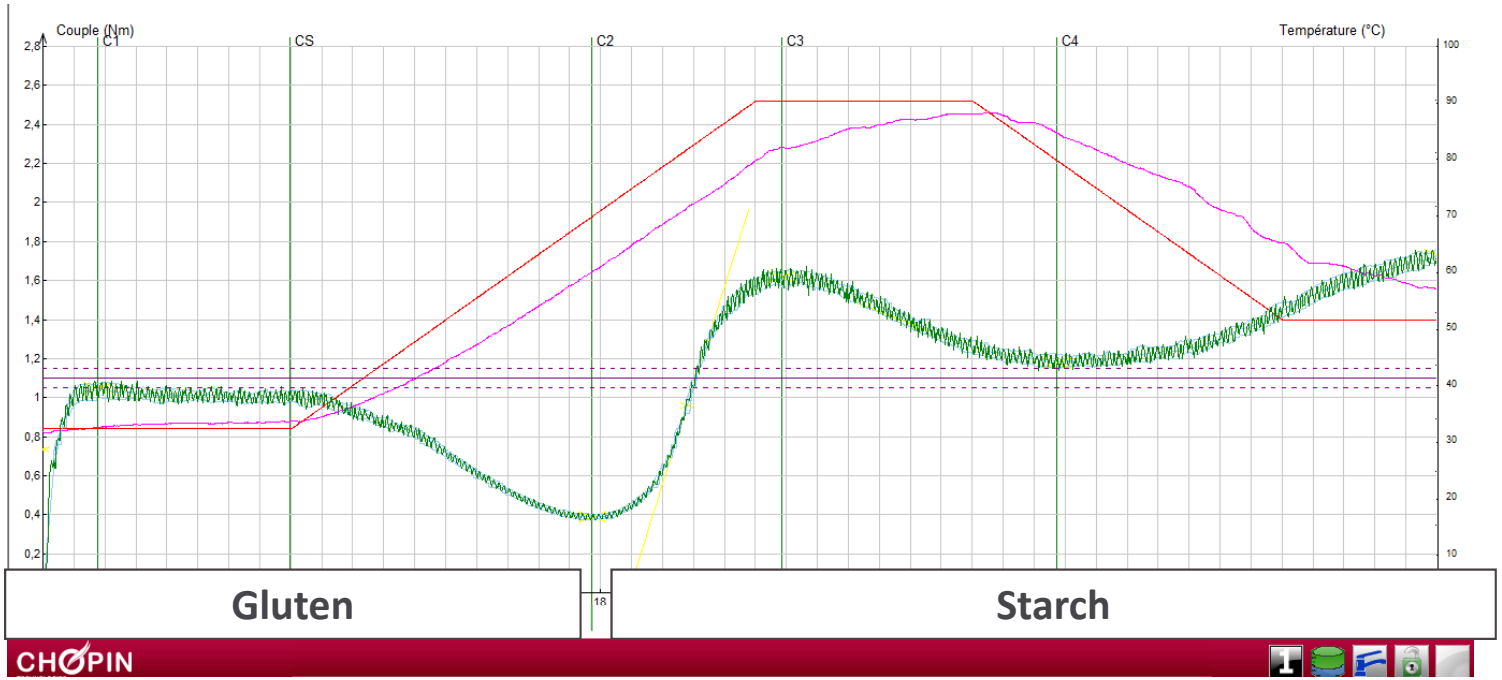
What is a Mixolab

The Mixolab measures the characteristics of dough during mixing (water absorption, development time, stability, etc..) while evaluating the quality of protein and starch.

User benefits:

By heating up and cooling down the dough in one test, you have a very complete dough rheology analysis.

Standard Mixolab curve



Compliant with

ICC 173/1 ; AACC 54-60-01 ; NF V03-765 ; ISO 17718:2013 ; GOST R 54498-2011

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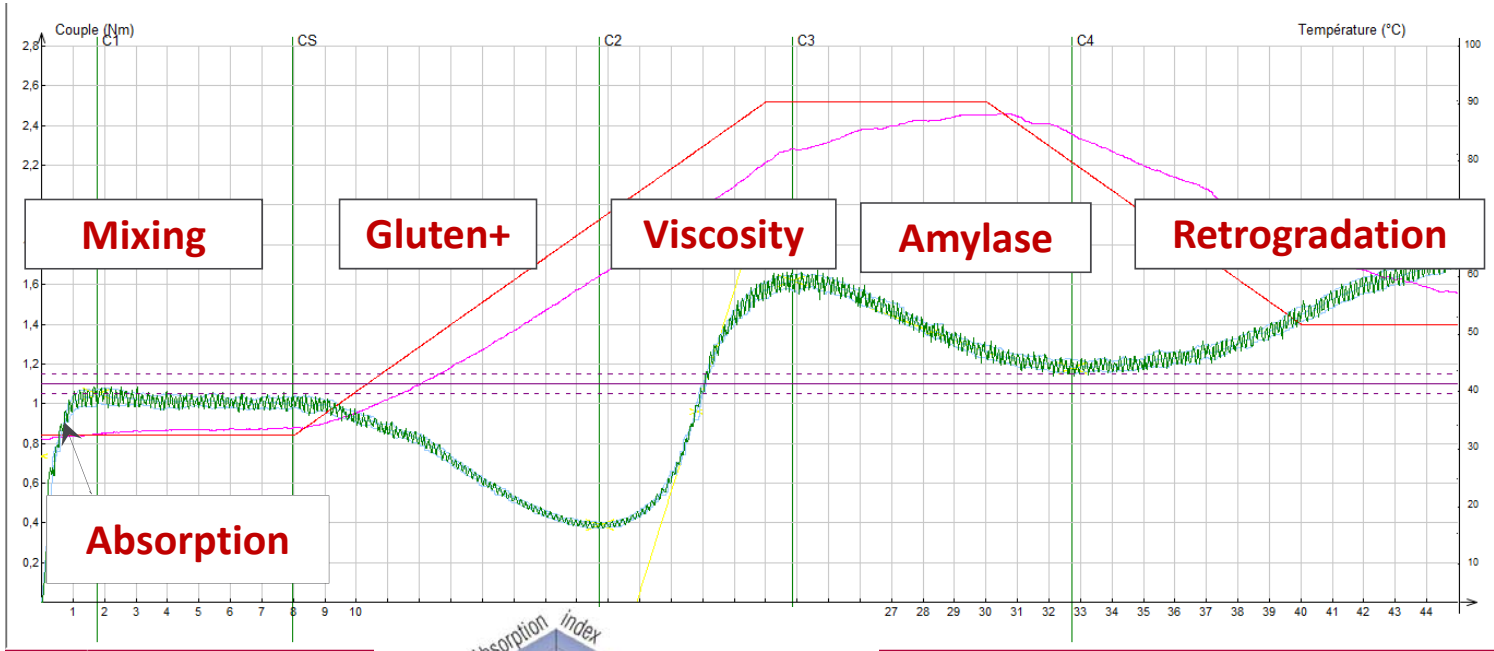
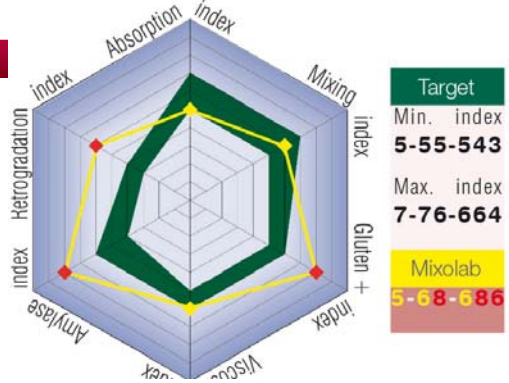
Mixolab Profiler : make it simple



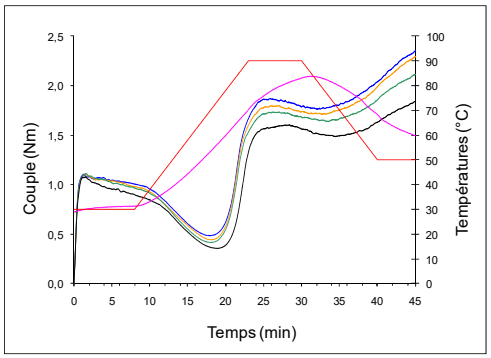


Target	
Min. index	5-55-543
Max. index	7-76-664
Mixolab	5-68-686

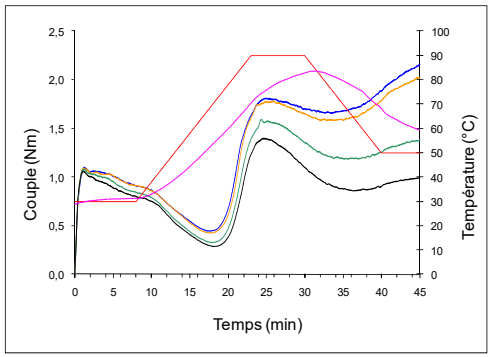
Index type	Values	Significance : the higher the index value the...
ABSORPTION	From 0 to 9	... more the flour absorbs water
MIXING		... more the flour is stable at kneading
GLUTEN+		... more the gluten resists heat
VISCOSITY		... greater the dough's viscosity when heated
AMYLASE		... weaker the amylase activity
RETROGRADATION		... shorter the cooked product's shelf life will be

Example 1 : α-amylase testing

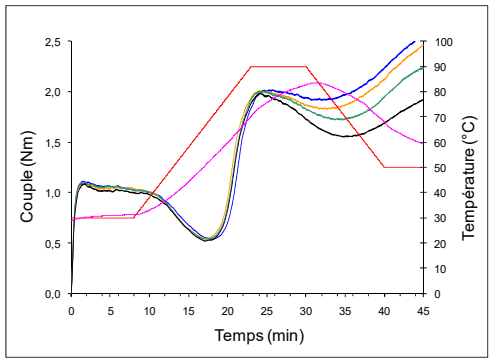
Fungal



Bacterial



Maltogenic



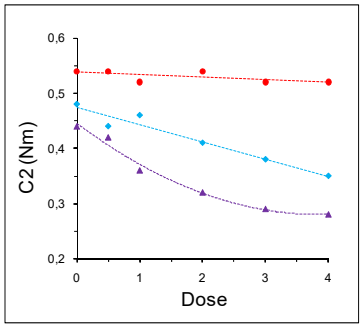
Only flour

Flour + 1 dose

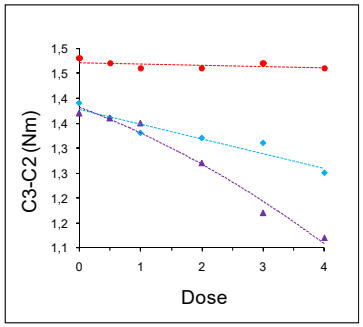
Flour + 2 doses

Flour + 4 doses

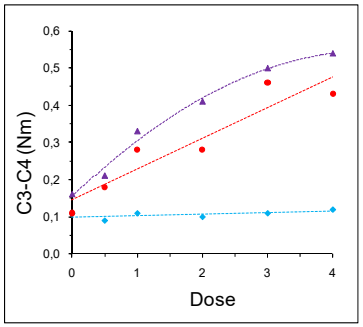
Protein



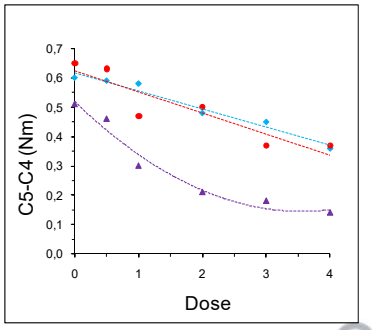
Gelatinization



Liquefaction



Rétrogradation



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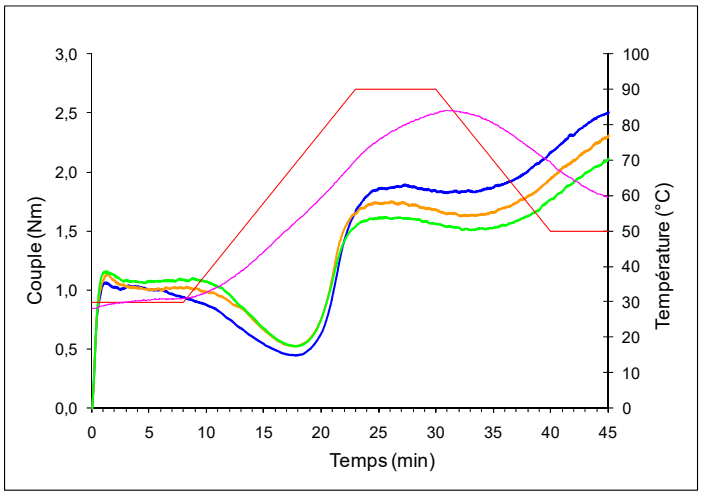
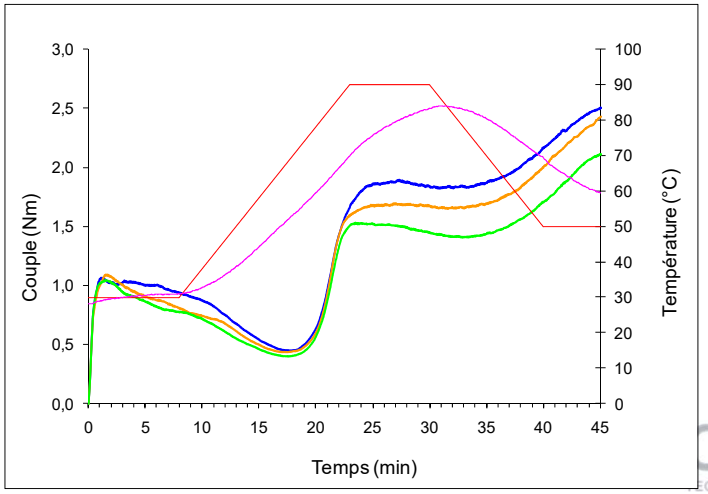
Example 2: Gums testing



"Thickening"
Carrageenan

"Gelling"
Carrageenan



0,0 % carrageenan

0,5 % carrageenan

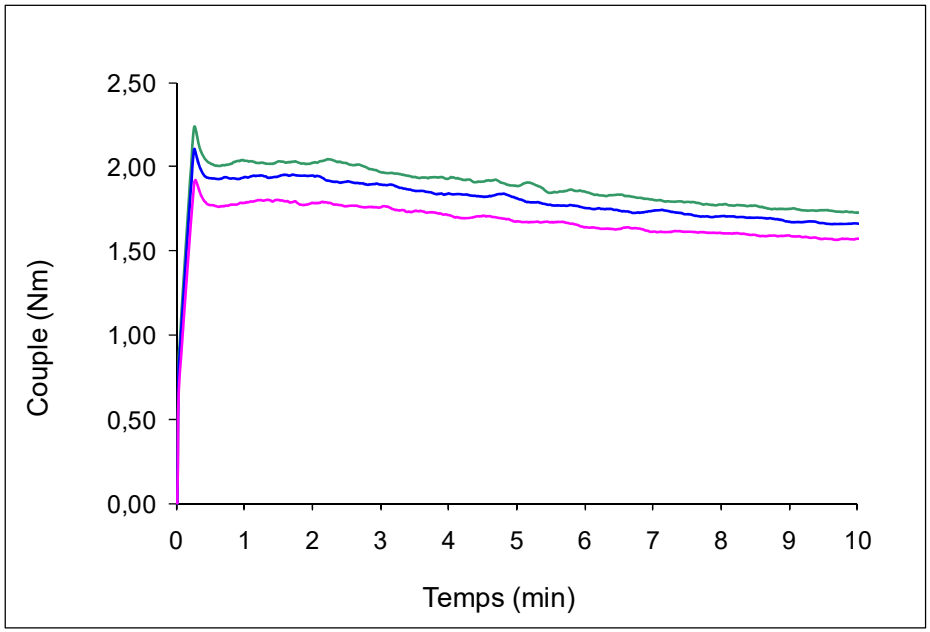
1,0 % carrageenan

And why not testing a dough piece from the production line?

- In this example, dough was taking from the industrial mixer while they were looking at hydration impact on dough texture

- Industrial mixer:
  - Flour : 80 Kg
    - Water : 36,2 L
    - Water : 36,4 L
    - Water : 36,8 L

- Mixolab:
  - Dough sample: 100 g
  - Rotation speed: 100 rpm
  - Mixer temperature: 26°C



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CONCLUSION

Remider :
Flour-related main control points

	Protein	Starch	Water
Size & shape	++++ (extensibility/Elasticity)		++ (Overhydration)
Rollability	+++ (Protein content…and quality)	++++ (Properties improved with Amylase action) +++ (Starch damage)	
Appearance	++++ (Cracks, Edges, Pillowing, Texture)	+++ (Cracks, texture)	++ (Pillowing)
Stickiness	++++ (Protein content…and quality)	+++ (Starch properties)	++ (Overhydration)
Shelf Life	++++ (Protein content…and quality)	+++ (Starch Properties) +++ (Starch damage)	

Take home message:
Which device for controlling flour quality for Tortilla production?

Wheat Tortilla parameter	NIRS	SDMATIC	Alveolab	Mixolab
Size & shape			+++++ Extensibility/Elasticity	+++ Hydration
Rollability	+ content	+++ High level	+++++ Protein quality	++++ Amylase, starch damage
Appearance			+++++ Protein on crack, edges, pillowing, exture	+++++ Starch properties action on Cracks and texture
Stickiness	+ content	++ High level	+++ Protein quality	++++ Starch properties, hydration
Shelf Life	+ content	+++ High	++++ Protein quality	+++++ Starch properties and damaged starch
Ingredient evaluation			+++++ Ready	+++++ Ready
Work on complete formulas			+++++ Ready	+++++ Ready
Work on dough coming from production line			++ Possible	+++++ Ready

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