CHOPIN TECHNOLOGIES

Tuesday 12/12 - 12:00-12:30 Paper # 13 Technical

Starch Damage : impact & control

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Starch Damage : impact & control

1/ The damaged starch

2/ The milling
Industrial
Laboratory

3/ Effects on final products.

4/ comparative results & interpretations.

5/ Methods for its measurement.

6/ Description of a new method

7/ Conclusions.

Why should we care about damaged starch ?

- Satisfy the customers
- Having a good product
- Having a good economical result

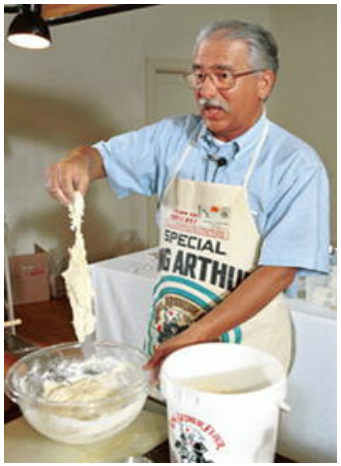
Why should we care about damaged starch ?

Because bread has a Simple process :

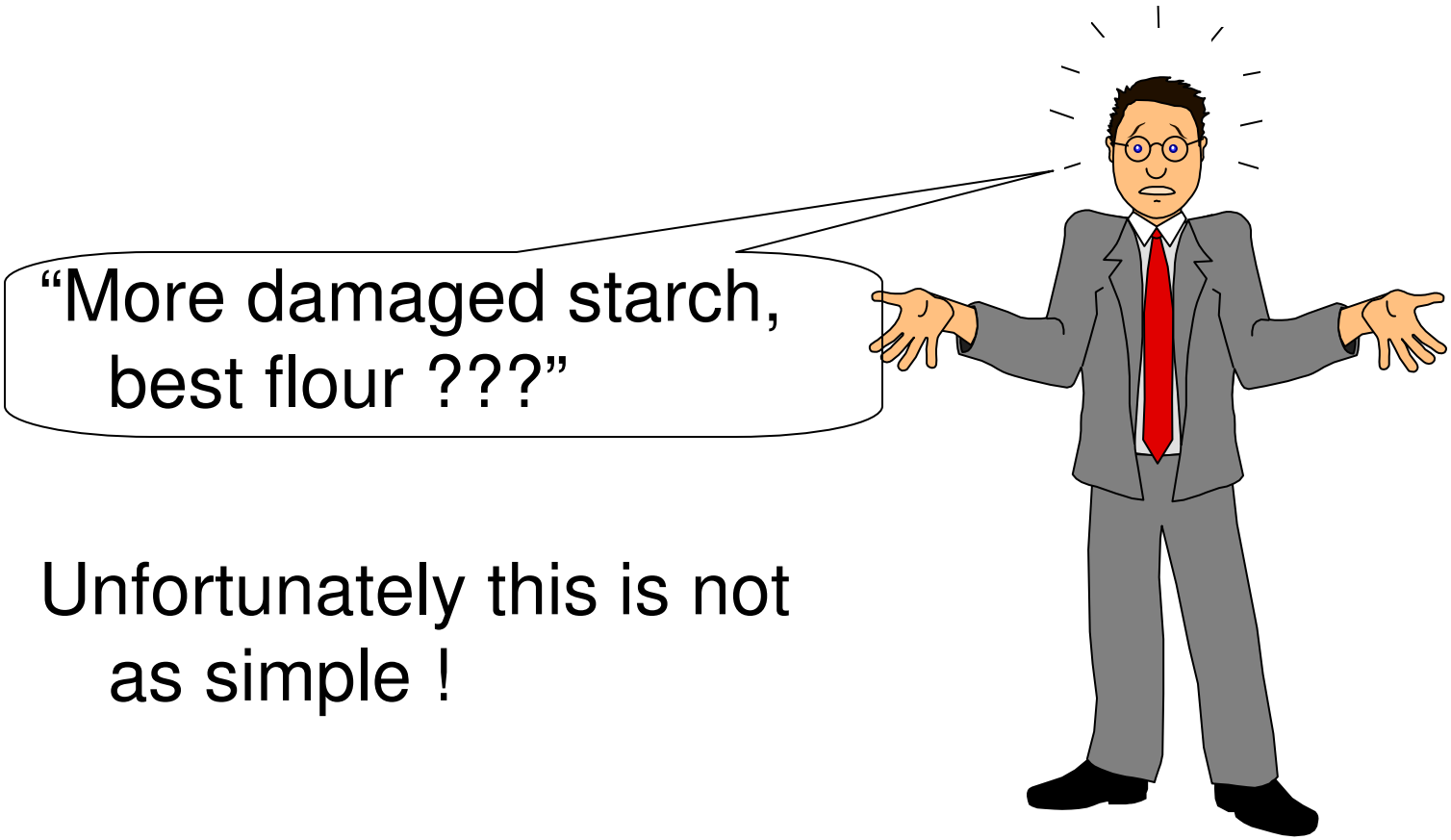
- Formula
  - Flour
  - Water
  - Yeast & salt.
- Kneading,
- molding,
- proofing,
- baking

Why should we care about damaged starch ?

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

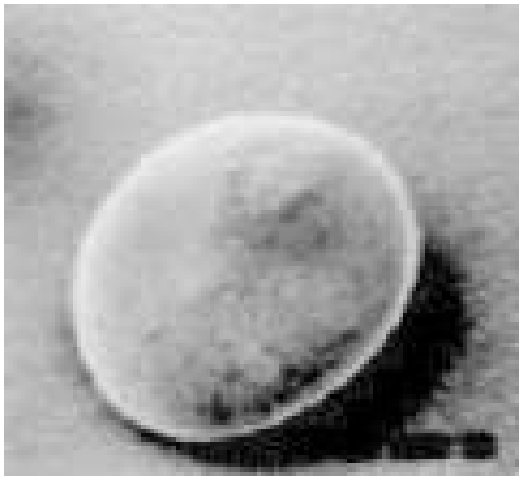


Why should we care about damaged starch ?



Unfortunately this is not as simple !

What is starch ?

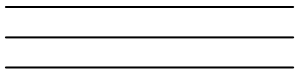


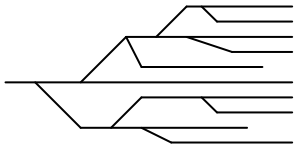
-70% of the wheat flour weight

-From corn, wheat, rice, tapioca and potato

-Large molecule of glucose units chains

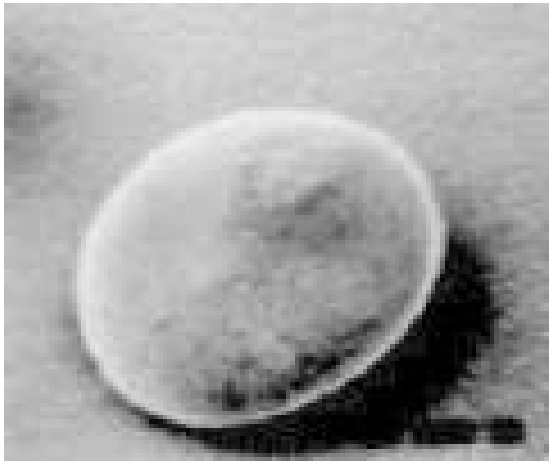
- -Amylose : straight-chain polymer
  - -More Amylose = molecules are regularly ordered to form strong & crystalline structure
- -Amylopectin : branched-chain molecule
  - -More Amylopectin = molecules are more random and have amorphous & readily disrupted structure
- -Both packed tightly into the solid starch granule

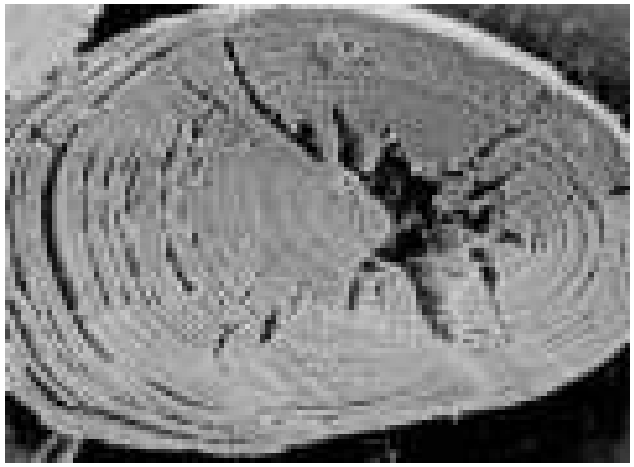




Where does it come from ?

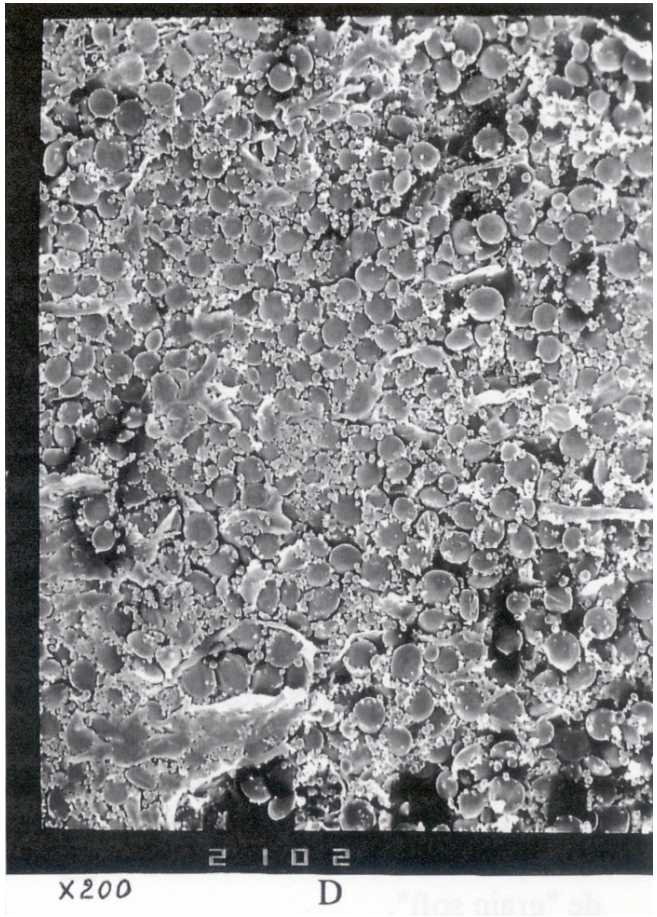
- Starch granule can be native, that is to say, without any mechanical damage
- Or it can be mechanically damaged
- This drastically change the granule characteristics and properties





Hardness

« Soft » Wheat



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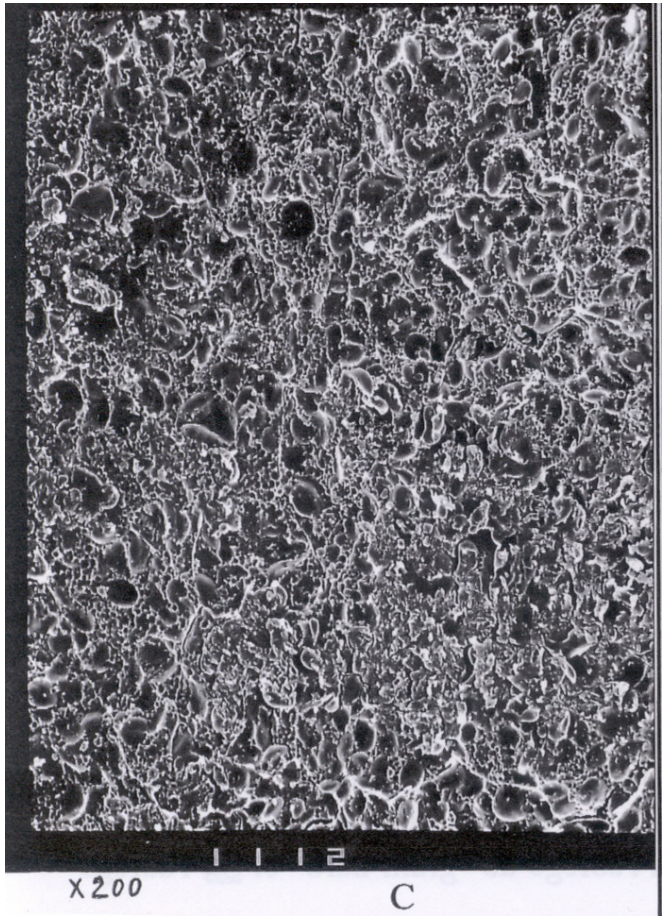

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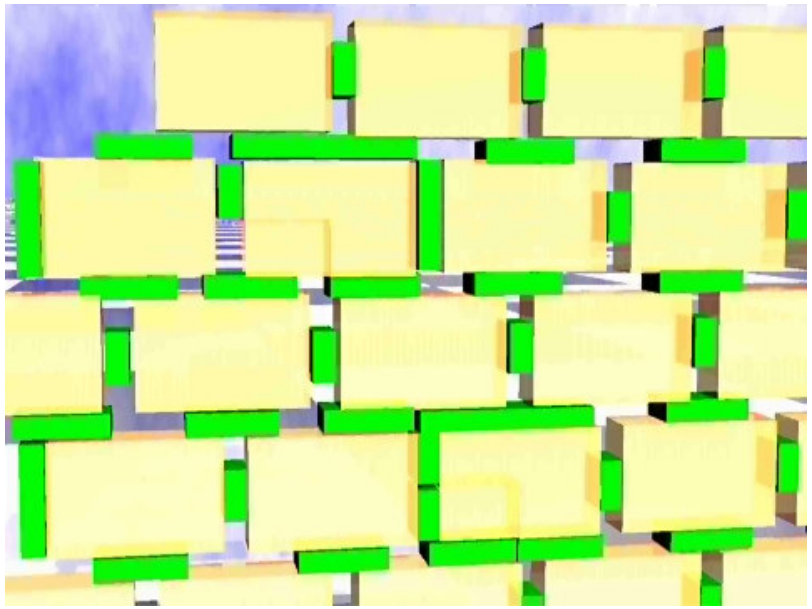

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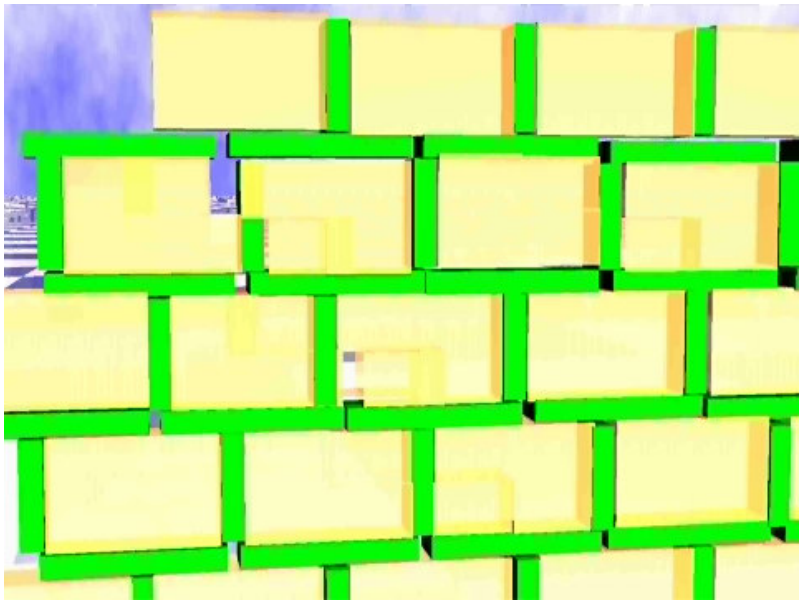

Hardness

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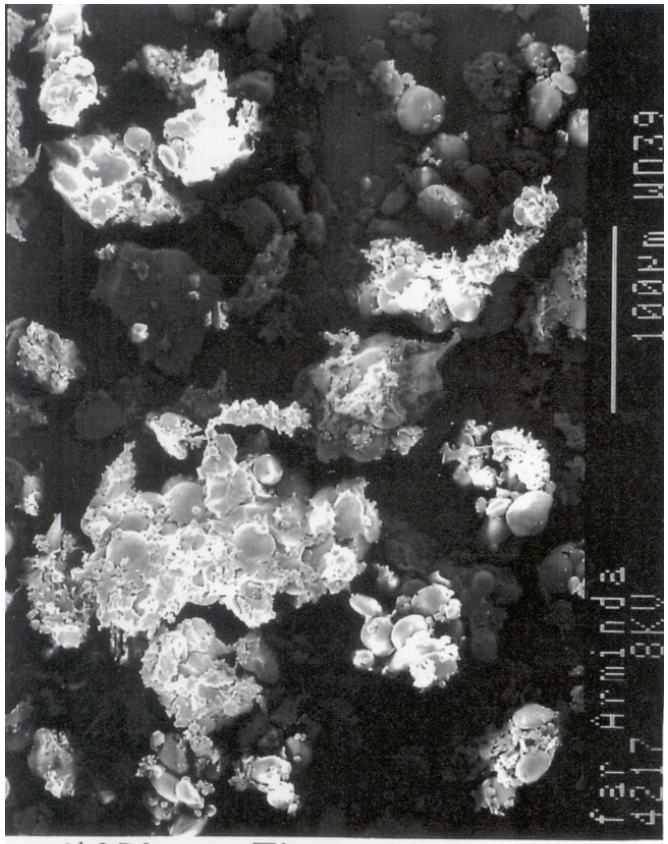
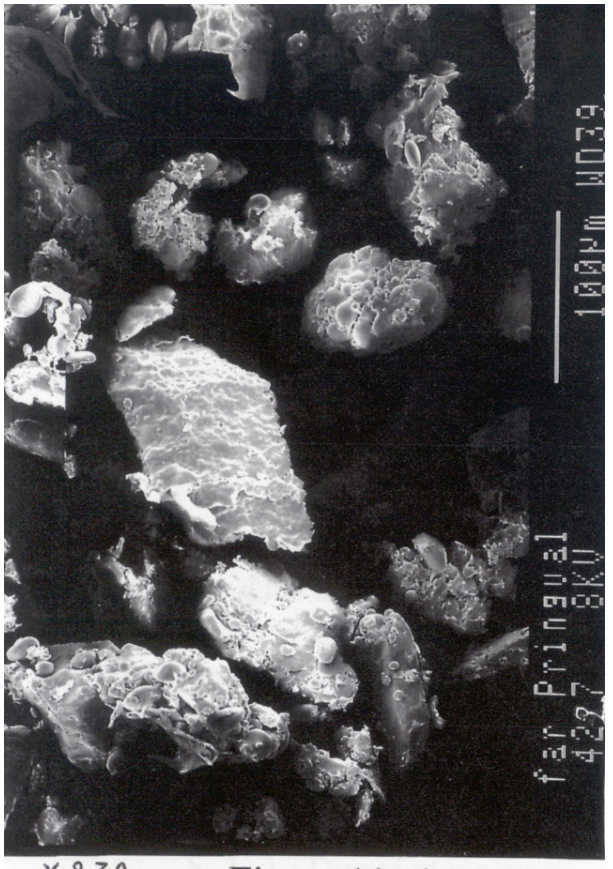


X 230 Figure 11–B

« Hard » Wheat



X 230 Figure 11–A

Where does it comes from ?

1/ The damaged starch

2/ The milling Industrial Laboratory

3/ Effects on final products.

4/ comparative results & interpretations.

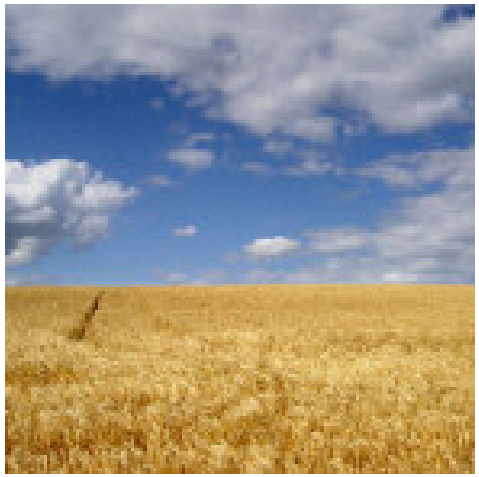
5/ Methods for its measurement.

6/ Description of a new method

7/ Conclusions.

- Damaged starch comes from the wheat itself (as a function of hardness)

  -genetic criteria-



- It also come from milling, including wheat tempering.

  -Mechanical criteria-

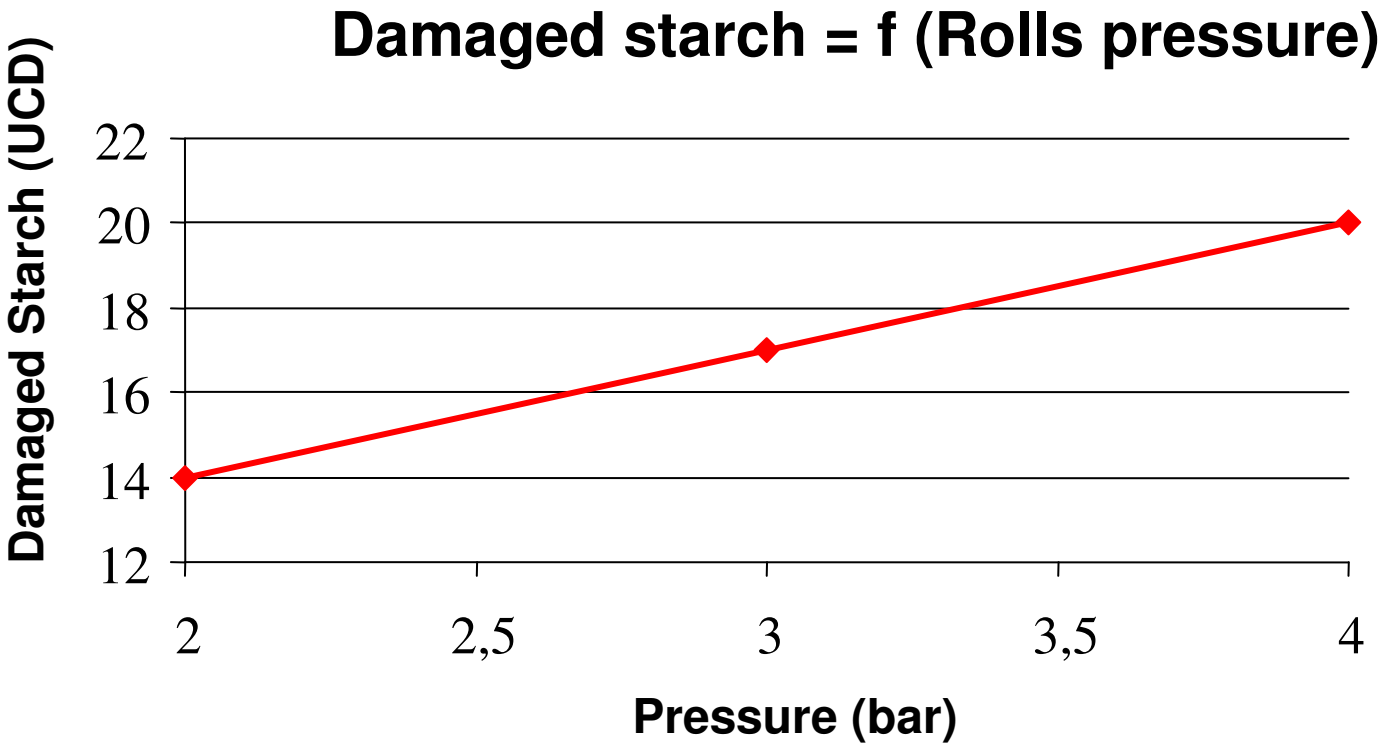
Where does it comes from ?
A/ genetic criteria

- For the same milling process, a hard kernel :

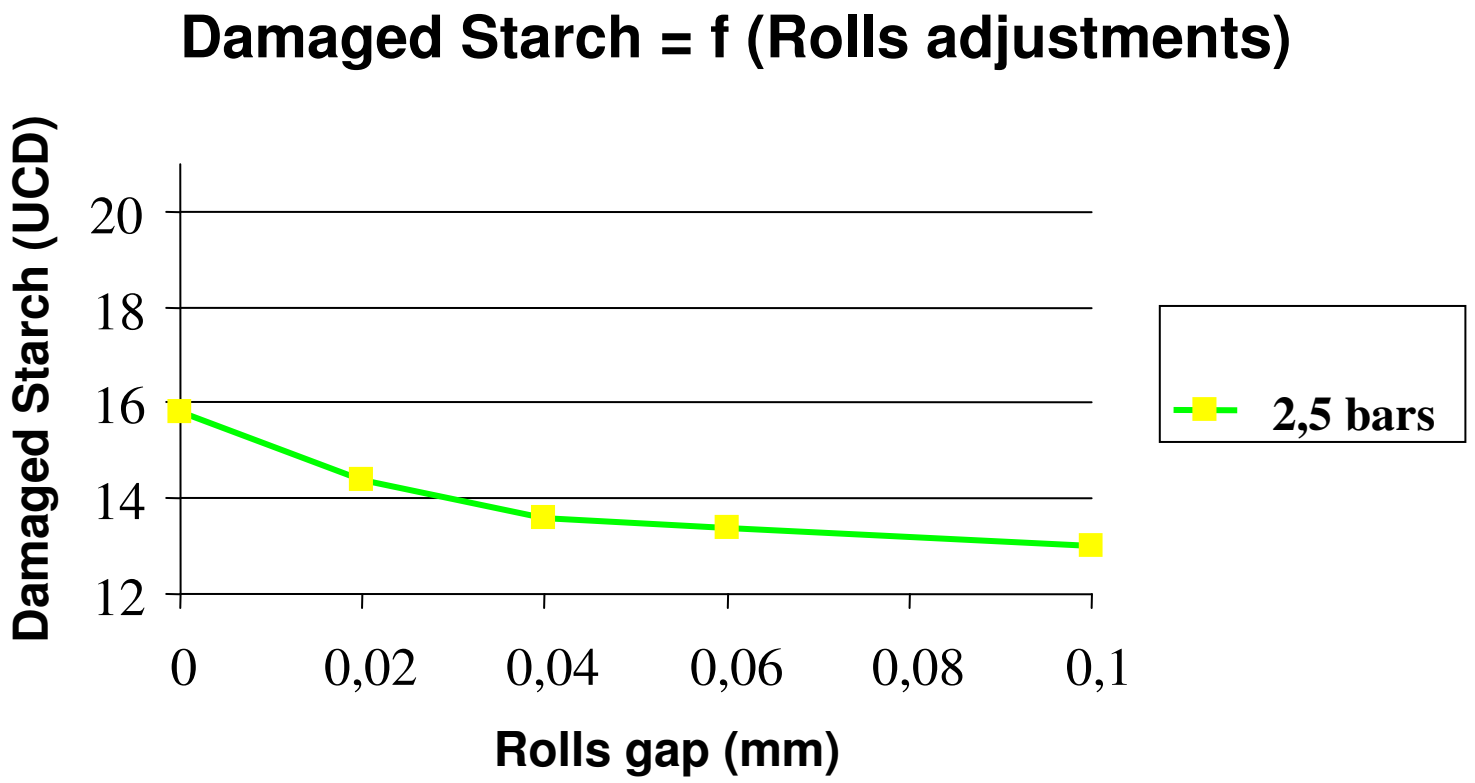
- Needs a longer resting time
- Produce more semolina during breaking
- Produce a flour with more damaged starch

“Wheat hardness can be described as a -resistance to crushing”

Where does it comes from ?
B/ Mechanical criteria



Where does it comes from ?
B/ Mechanical criteria



Where does it comes from ?
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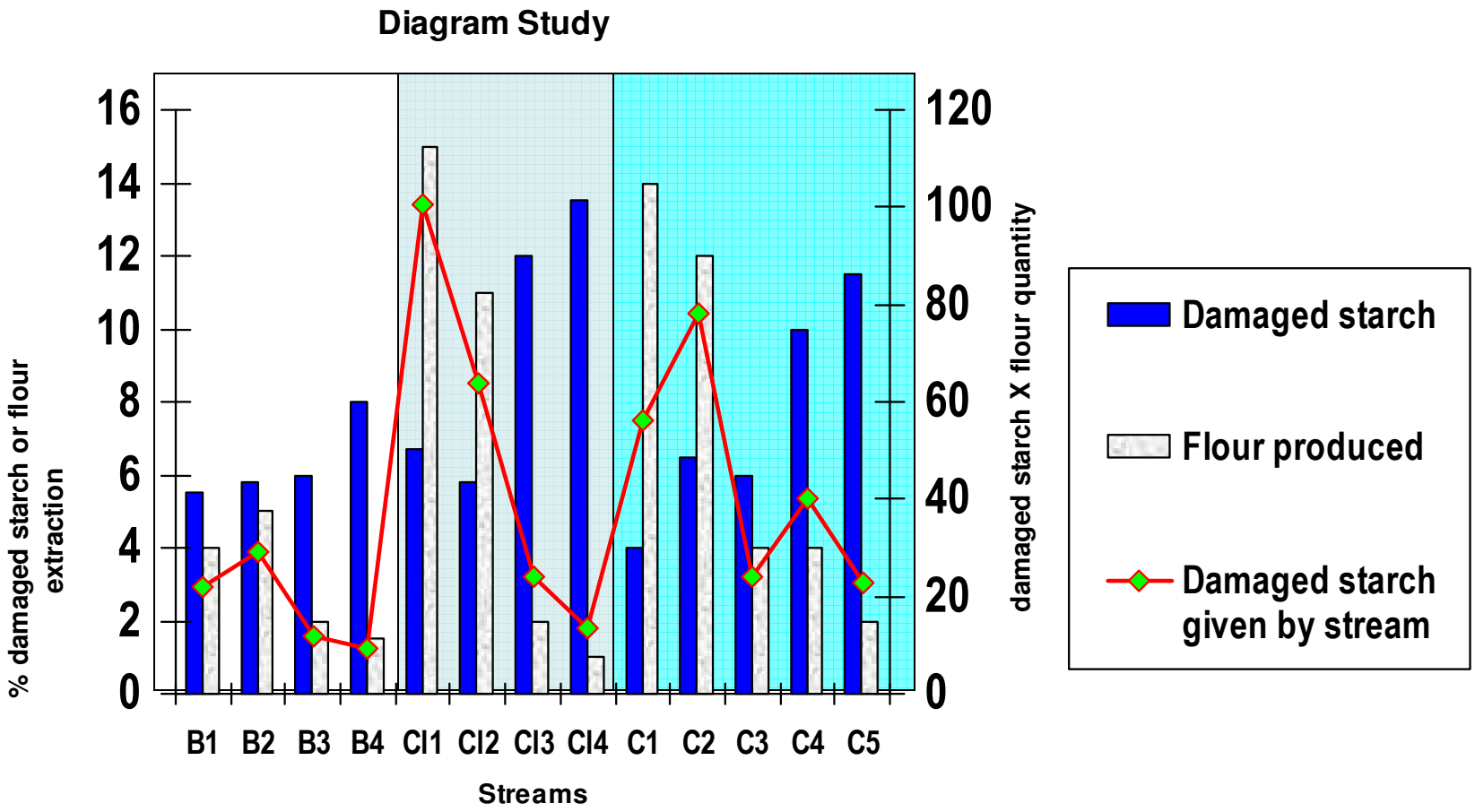

Effects on the final product

1/ The damaged starch

2/ The milling
Industrial
Laboratory

3/ Effects on final products.

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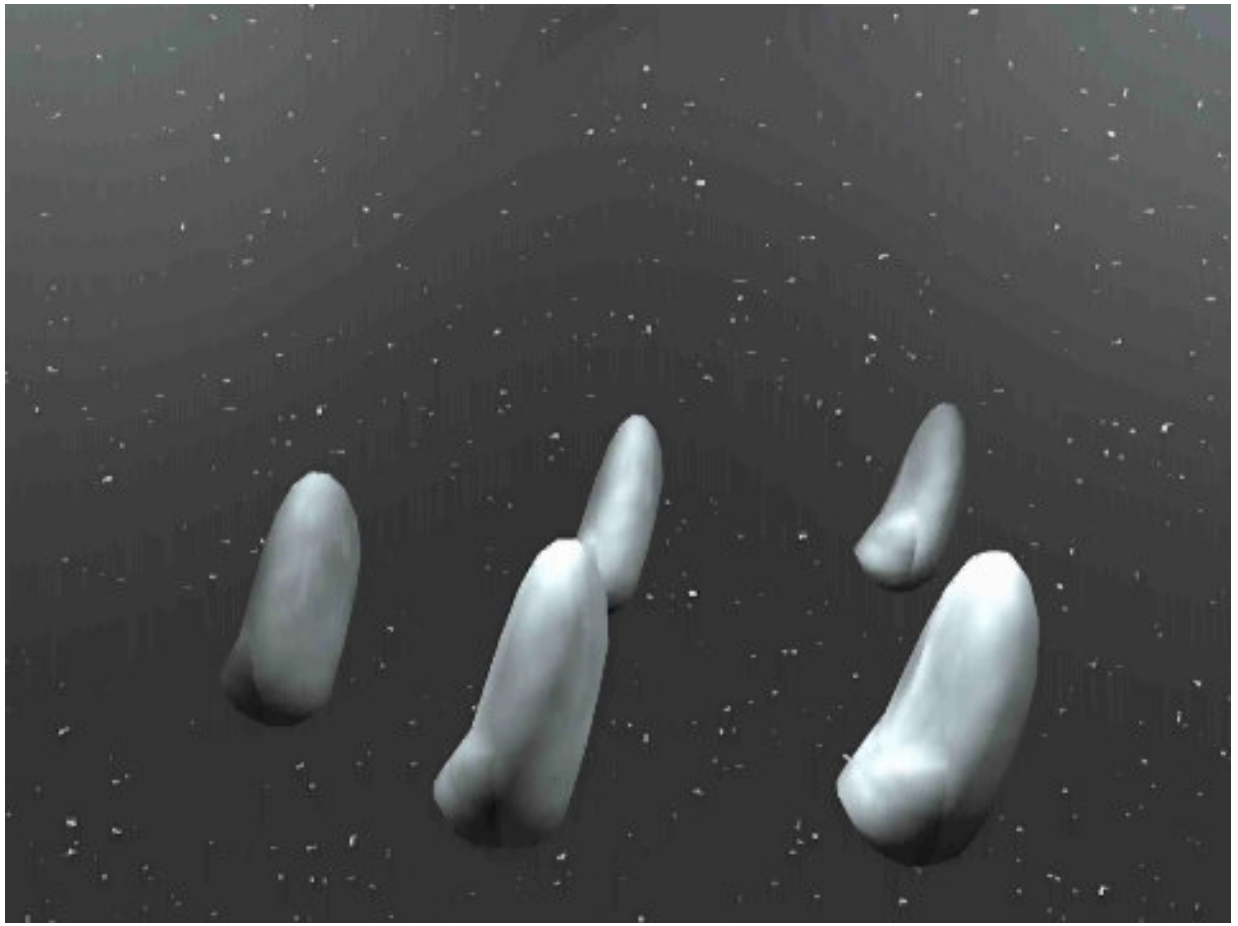
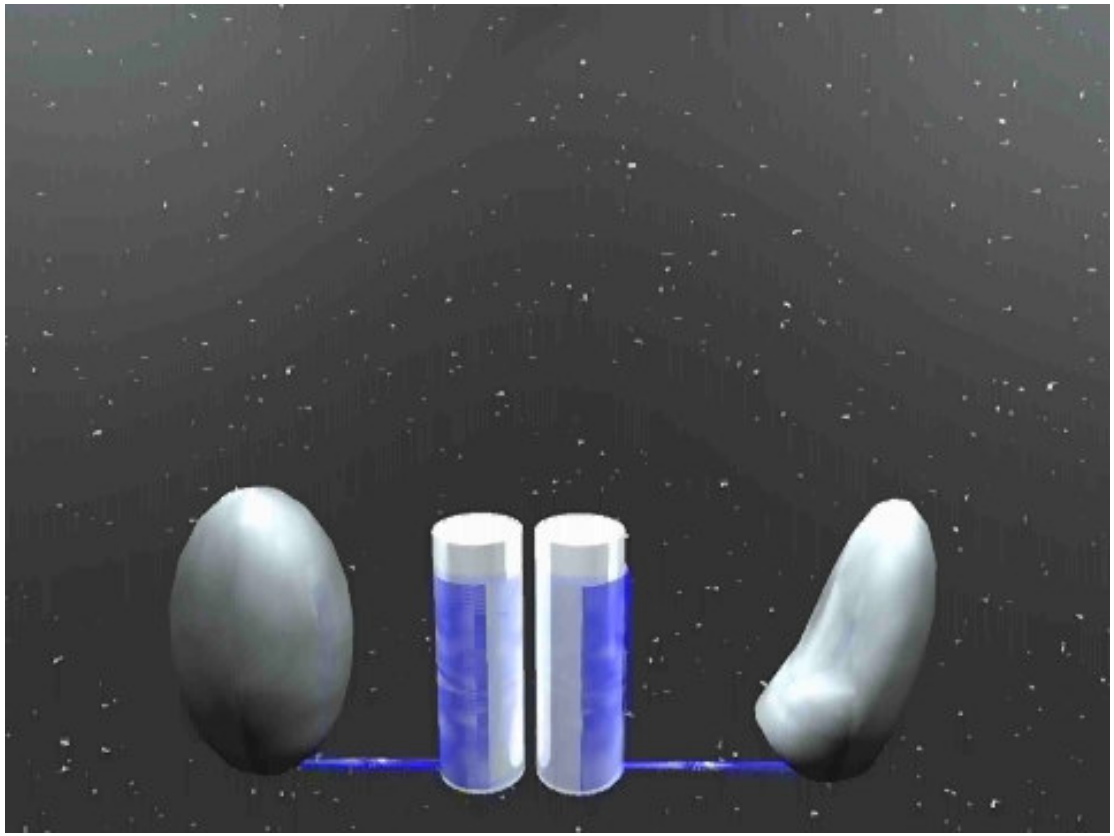


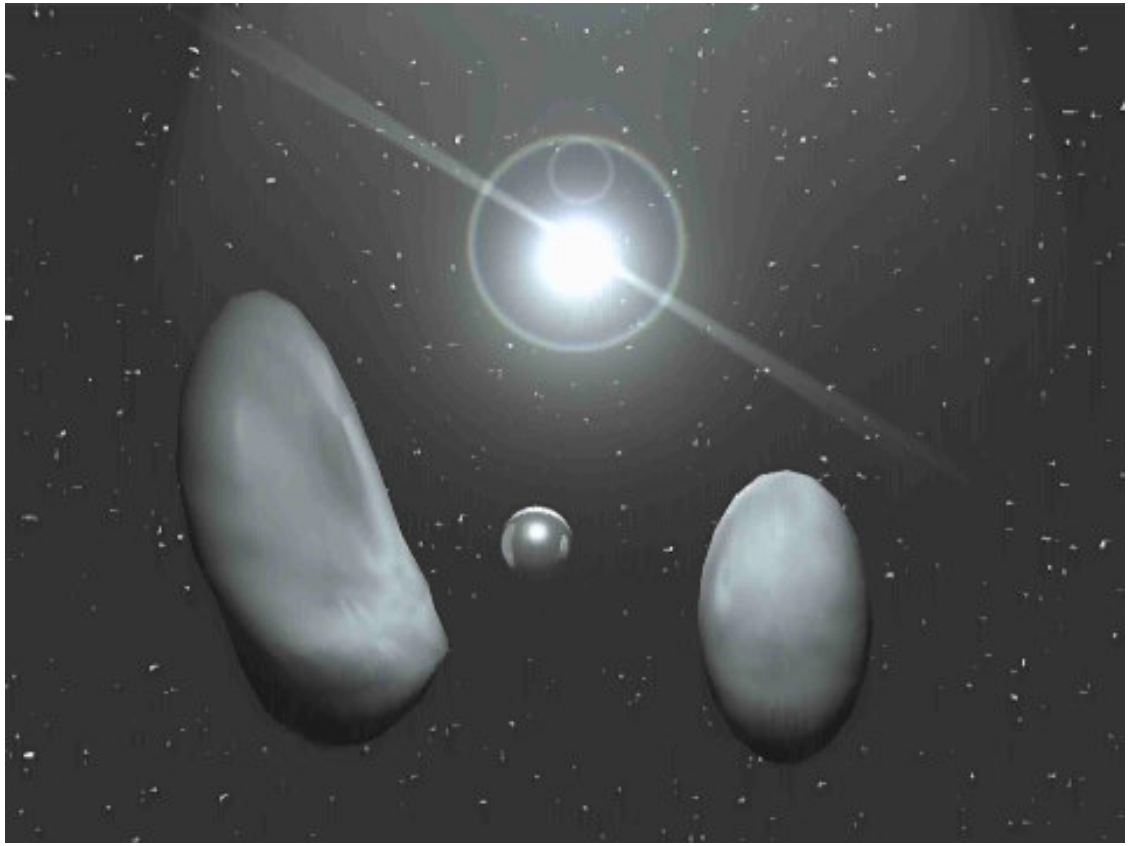
Absorption

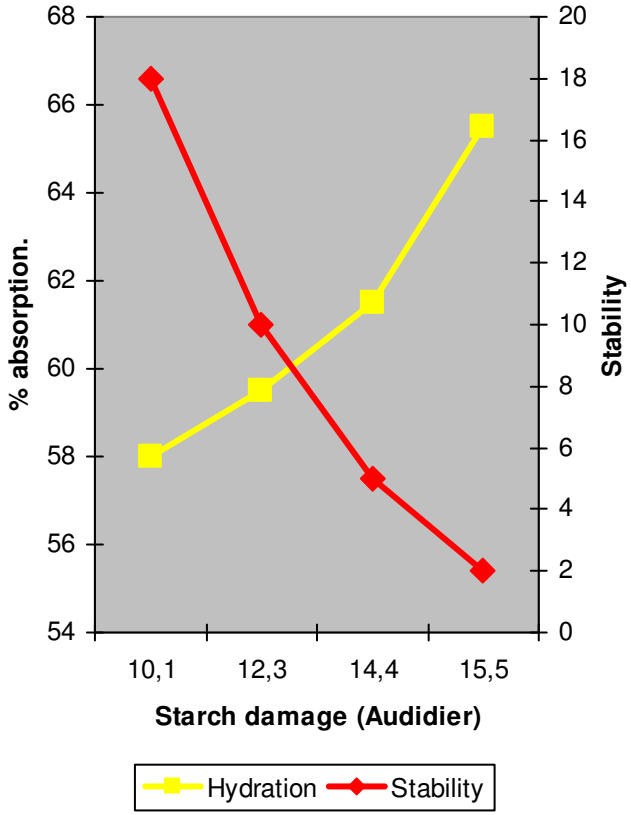


- Protein absorbs 1.8 times its weight of water
- Pentosans 10 times..
- Native starch 0.4 times...
- Damaged starch 4 times…

Water absorption by starch that become damaged can ***improve baking properties up to a critical level*** above which properties of flour are negatively affected.

Water Release





Why to care about damaged starch? Concept

	What we look for	To be avoided
Keading	• A High yield (Water absorption capacity) • Good tolerance	• Sticky dough • Low hydrating flour
Molding	• Good tolerance • Good behavior	• Sticky dough • Dougth too tough or soft
Proofing	• Good volume • Taste development	• break down of dough with little volume
Baking	• Volume increase • A good color	• Dough collapsing in oven • Breads too “red”
After	• A good taste • A good conservation	• Too fast crumb hardening

In yellow, damaged starch action spots

How does it act ?

- Alongside with the action already determined on hydration, starch damage has an action on :

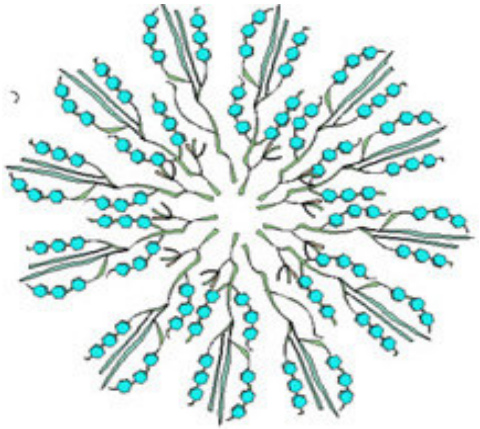
- Dough plastic characteristics
- Proofing
- Bread crust color

How does it act ?
Effects on proofing characteristics

- **Amylases can't attack a native starch granule.**
- **More damage more attacks are possible.**
- **Breaking the granule molecules liberates water.**
- **Simple sugar are present and create :**

Intense yeast activity (a lot of CO2)

Coloration possibility higher.



How does it act ?
Effects on final product

- Higher input of water allows to keep the loaf fresh longer.

<u>But :</u>

- Simple sugar release provokes a very red crust
- If intense, damaged starch can be responsible for :
  - Sticky crumb
  - No volume bread
  - Too red bread.

How does it act ?
Effects on final product

If I do not have enough starch damage

I can :

- Set the mill differently
- Choose a harder type of wheat...
- Both of them...

If I have too many starch damage

I can :

- Take care of amylases content (falling number)
- Add gluten to increase rheological properties.
- Set differently the mill
- Change wheat for a softer one…

In every case, we see the necessity for measuring the damaged starch in the flour !!!

All concerned!

- « Proofed » Bread
- Flat breads
- Biscuits
- Noodles, fideos (wheat flour)
- « Durum » Wheat
  - For breadmaking
  - For pasta
- Tortillas !!...

Comparative results & interpretations

1/ The damaged starch

2/ The milling
Industrial
Laboratory

3/ Effects on final products.

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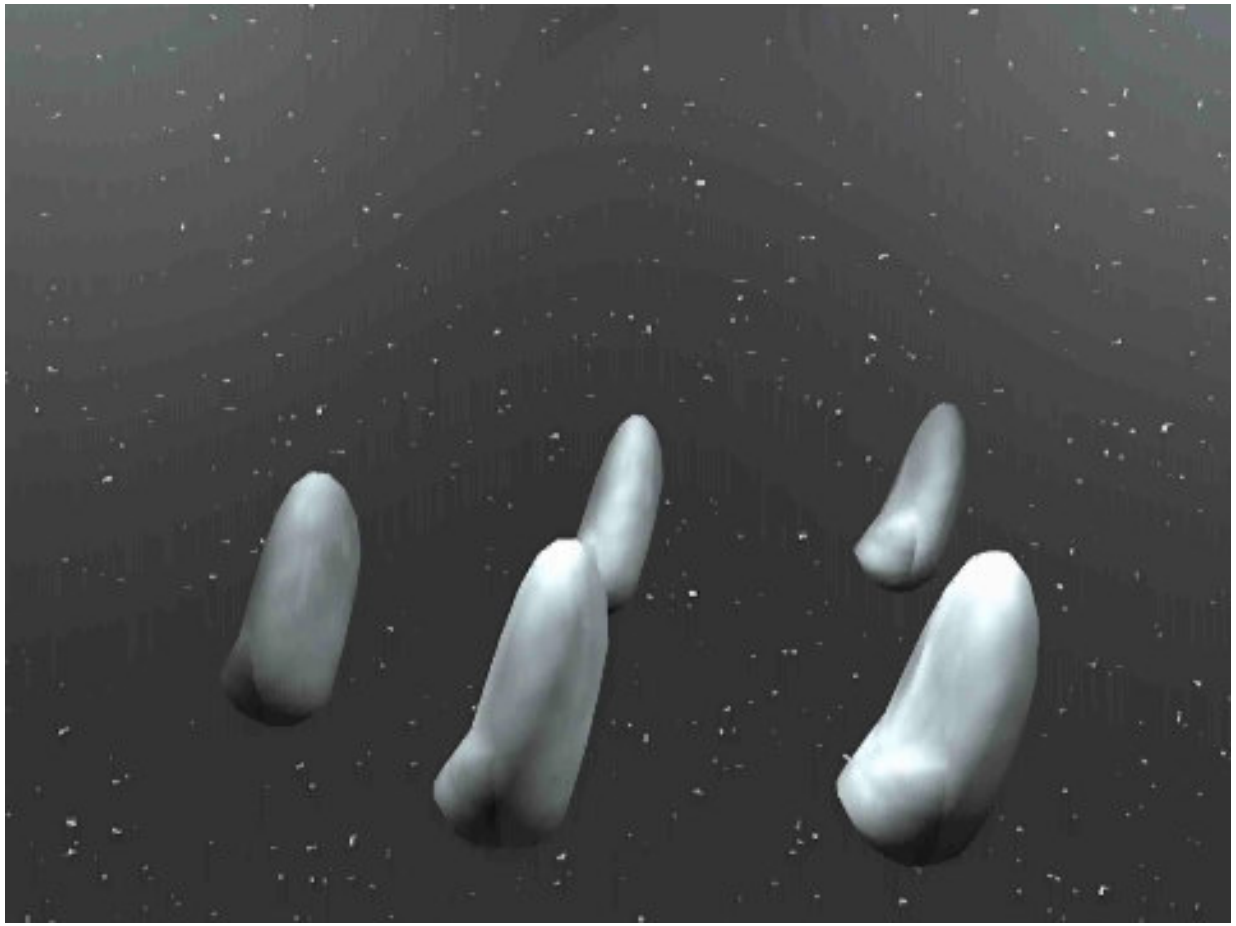
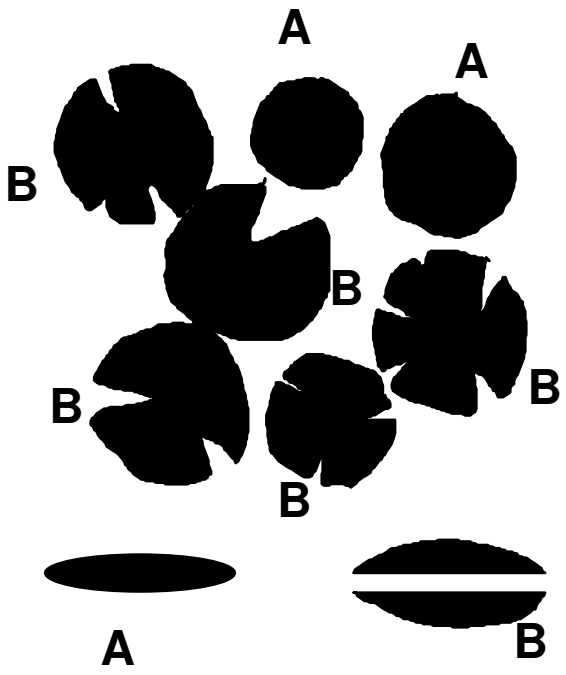
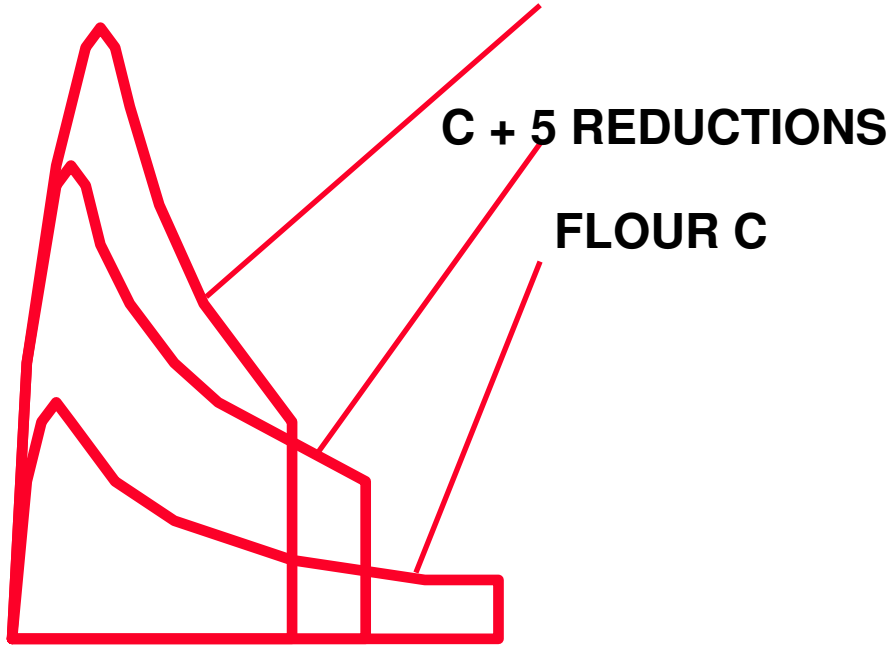
7/ Conclusions.



Starch damage



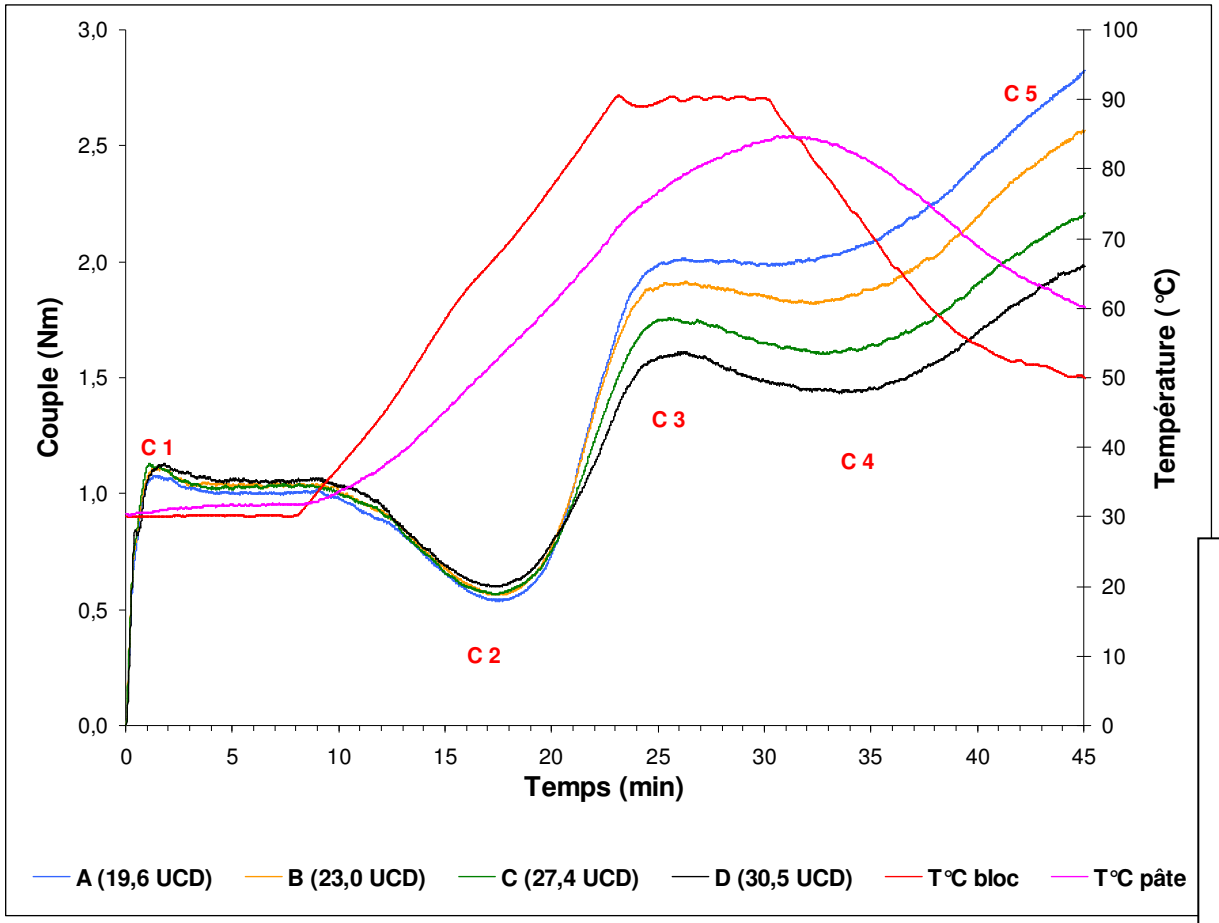


A : NATIVE STARCH

B : DAMAGED STARCH

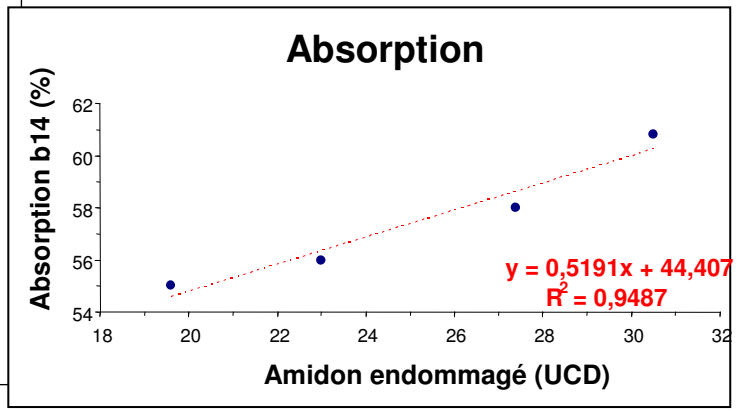
The damage Starch has an impact on the alveo graph curve and the rheological properties. The point is that the dough is under hydrated. This is increasing the tenacity (P) and decreasing the extensibility (L). (As Alveograph protocol has a constant hydratation).

Starch damage



Mixolab® shows the impact of the starch damage on the rheologic behaviour of doughs :

- Water absorption Capacity
- Gelatinization
- Cooking stabilty
- Gelification



This study assess the impact of this damaged starch on the rheological behaviour of dough (dough preparation, gelatinization, gelling).

Impact of damaged starch content :

The Mixolab® analyses carried out on the flour show that an increase in the damaged starch content results in :

> an ***increase in the water absorption capacity*** (approximately 0.5% hydration for each additional UCD) ;

> a decrease of the viscosity of the starch paste obtained during the gelatinization process (reduction of C3 and the C3-C2 difference) and reduced stability under heat (increased liquefaction, i.e. C3-C4 difference) ;***indicating higher amylasic activity***

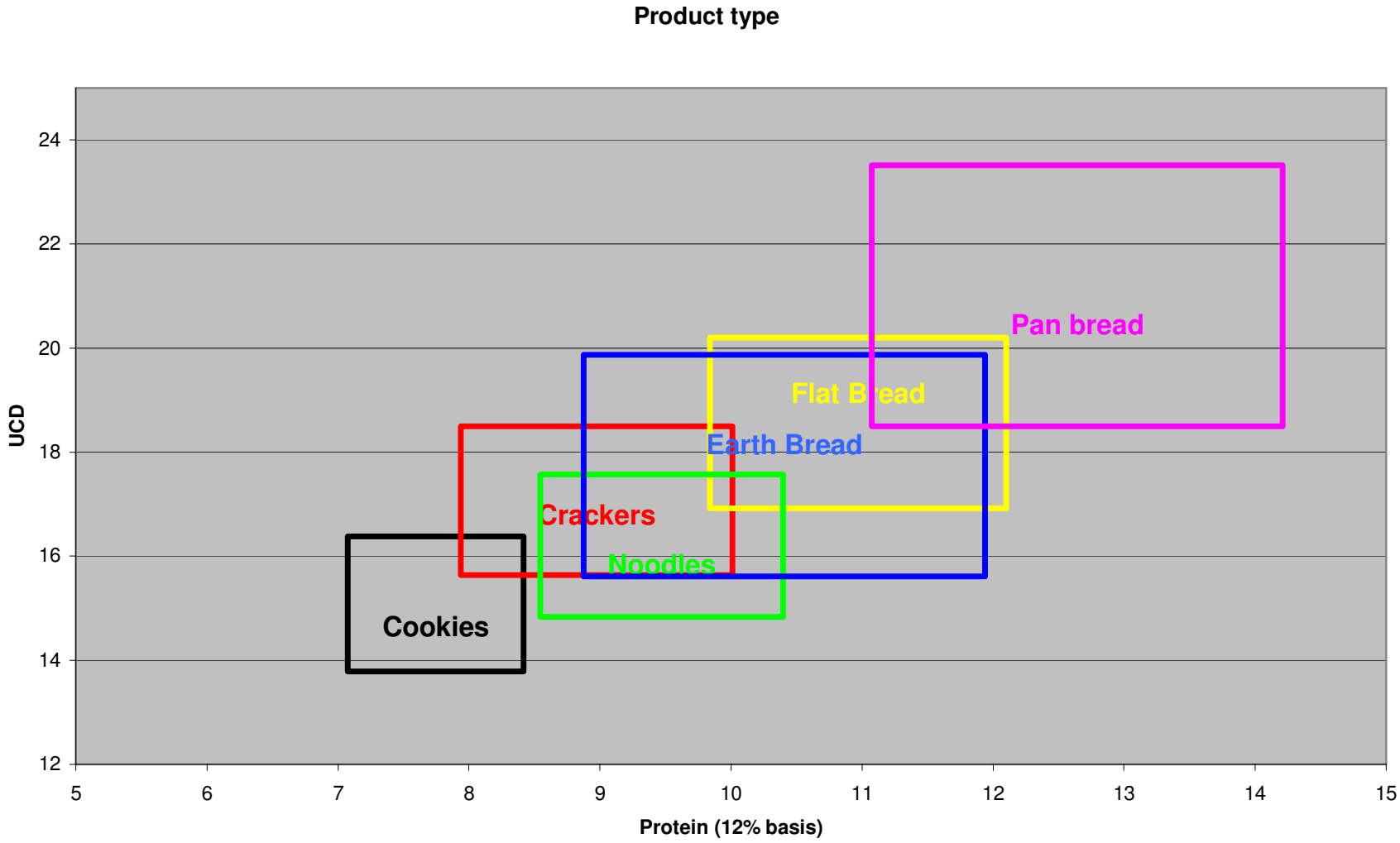
> a decrease of the starch retrogradation indicating ***better shelf life***

There is a clear explanation. The damaged starch presents a water absorption capacity ten times greater than the native starch, and greater sensitivity to enzymes (the amylases in particular). The action of the amylases occurs more quickly and in a more intensive manner.

CONCLUSION

The damaged starch action impacts the whole bread-making process. It is essential to adapt and quantify damaged starch content in accordance with the desired end use. The SDmatic / Mixolab® couple is perfectly suited to this challenge.

Products Classification according to damaged starch and protein content.



Methods of its measurement

1/ The damaged starch

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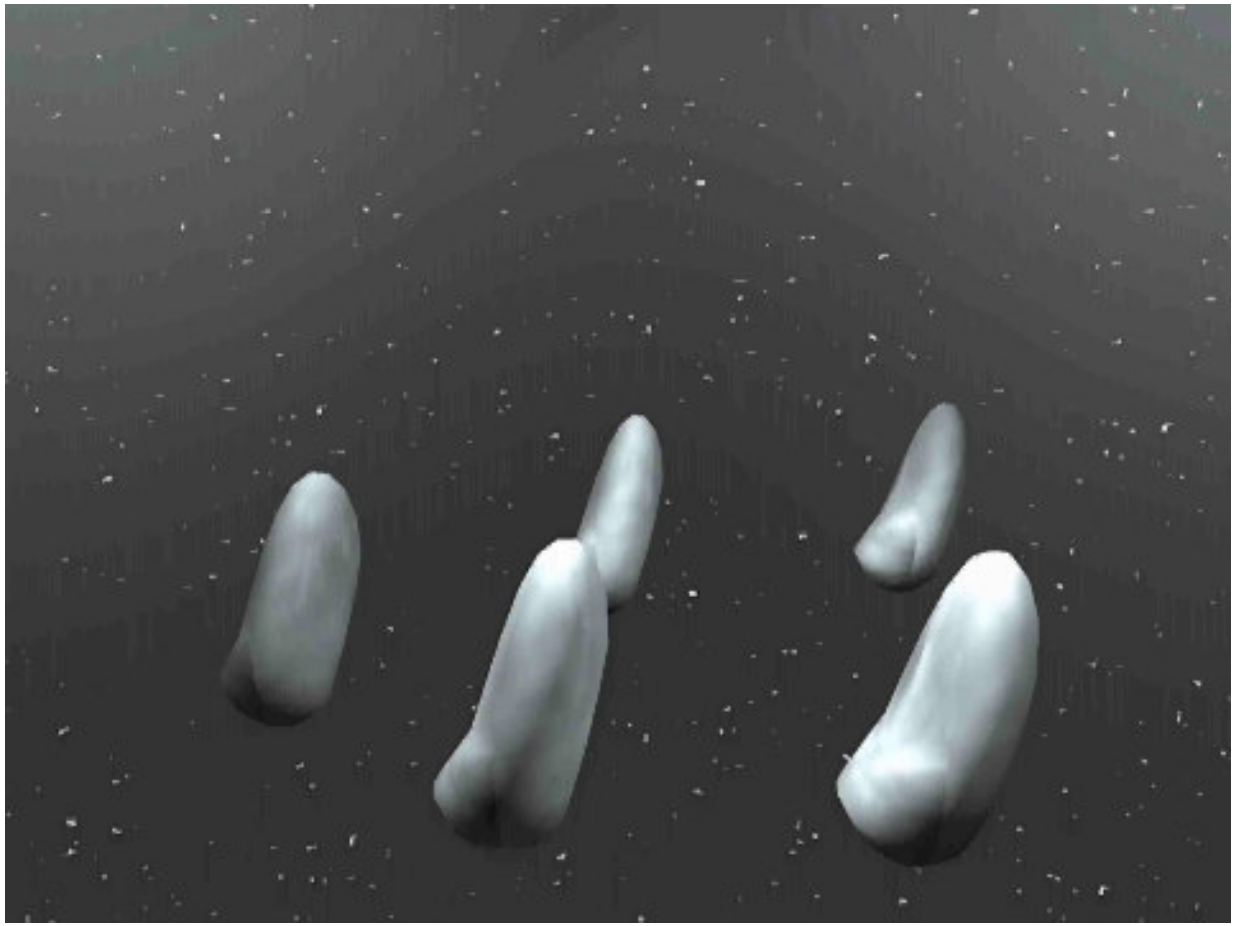


How to measure it ?

Existing methods :

- Colorimetric
- Polarimetric
- Spectrophotometric
- Enzymatic
- Amperometric

How to measure it ?

Existing methods :

- ~~Colorimetric~~
- ~~Polarimetric~~
- ~~Spectrophotometric~~
- Enzymatic
- Amperometric

Enzymatic method : Principle

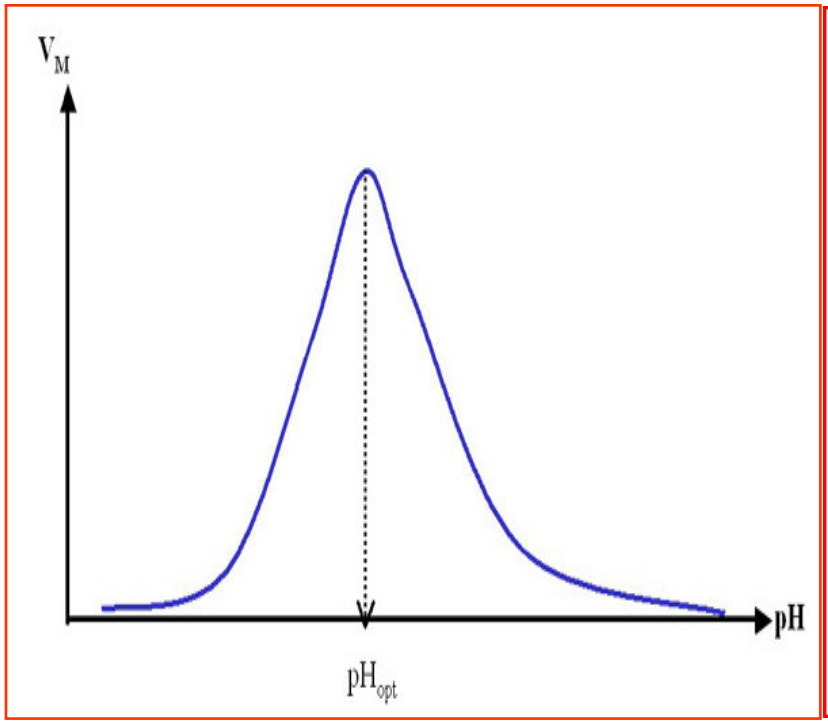
to use enzyme to generate and quantify reducing sugar (Maltose, Glucose) :

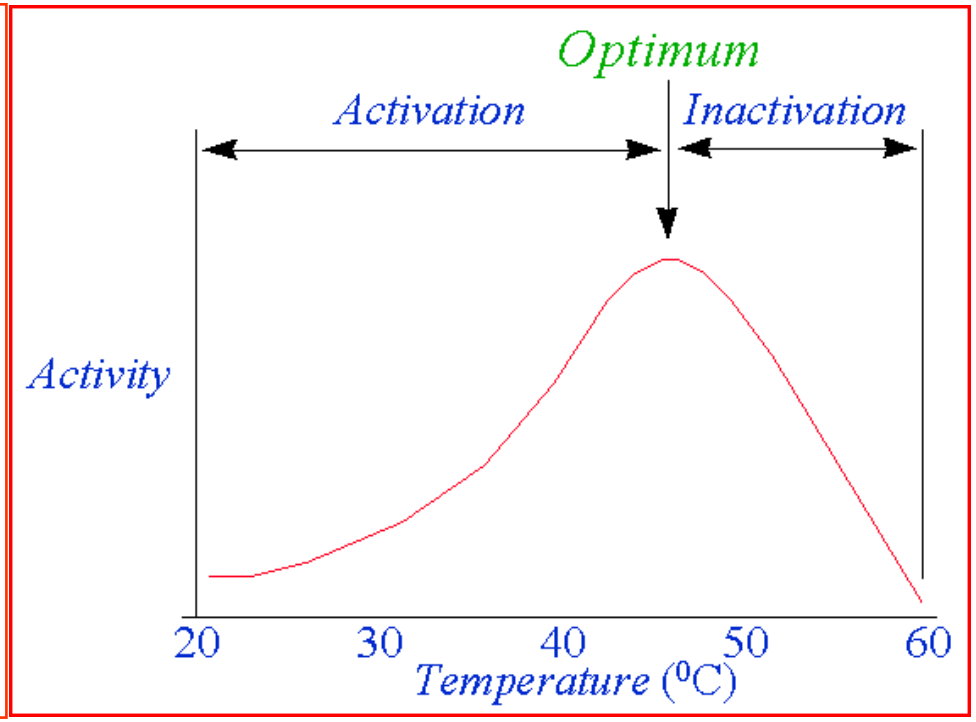
- Amylase use to damage starch granule
- Amylase inhibition after a specific time
- Enzymatic glucose chain cut to obtain maltose or glucose
- Reducing sugar quantization by spectrometric or other method

➔ starch damage content increase with the quantity of reducing sugar

Reminder about Enzymes

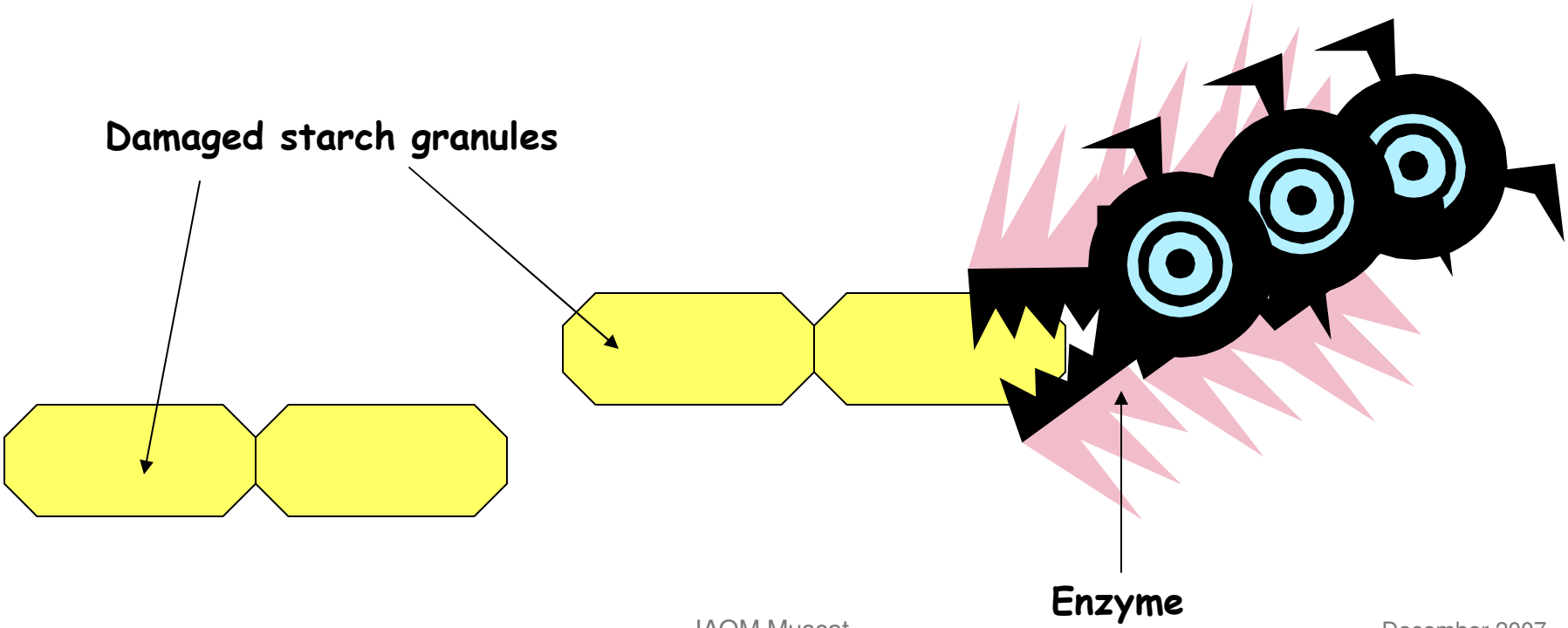
$$E+S \leftrightarrow ES \leftrightarrow EP \leftrightarrow E+P$$





Definition

This method determines the ***percentage*** of starch granules in flour or starch preparations that are susceptible to ***hydrolysis by α-amylase***.



What do you need?

- **Equipment :**
  - *Constant- temperature bath (30 °)*
  - *Micro-buret (10-ml)*
  - *Test tubes Pyrex (25 x 200-mm)*
  - *Spectrophotometer (only for Spectrophotometric method)…*
- **Reagents** :
  - *Acetate buffer*
  - *H_2SO_4 solution*
  - *Sodium tungstate solution*
  - *α-Amylase preparation…*

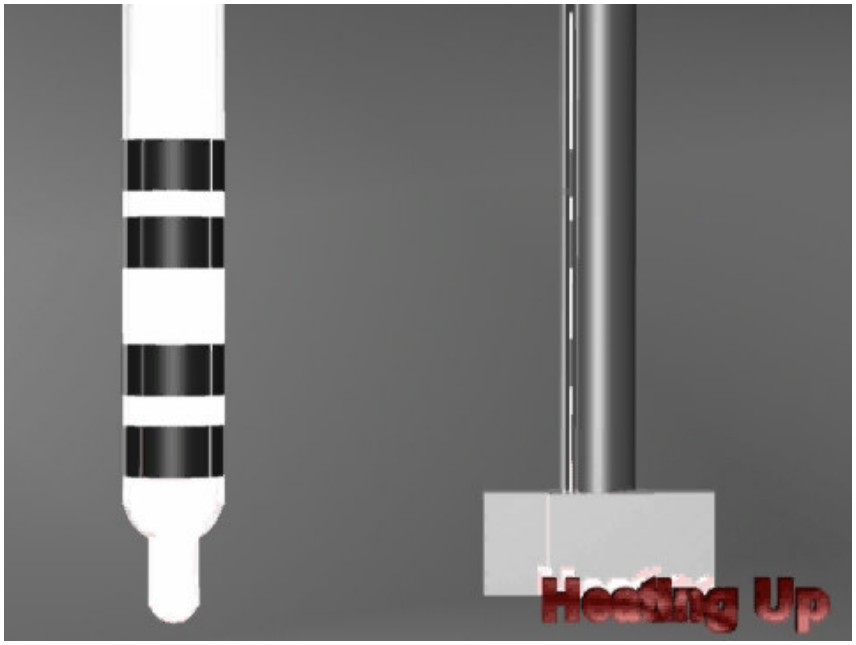
Long and hard procedure

- More than 10 **manipulations**
- Several **preparations** of reagents
- Strict **control** of environmental parameters
- Extreme **precision in times** and **temperatures**
- **Calculation** to carry out

Amperometric method

- The damaged starch method used by our SDmatic is an amperometric method. It is based on the affinity of the starch towards iodine (known reaction).

- Studies carried out in the USA in 1966 (Medcalf & Gilles) clearly showed that the measurement of the quantity of iodine absorbed by a sample of flour is proportional to its level of starch damage.



Description of a new method

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SDmatic

- Composition -

Tactil screen

Spoon

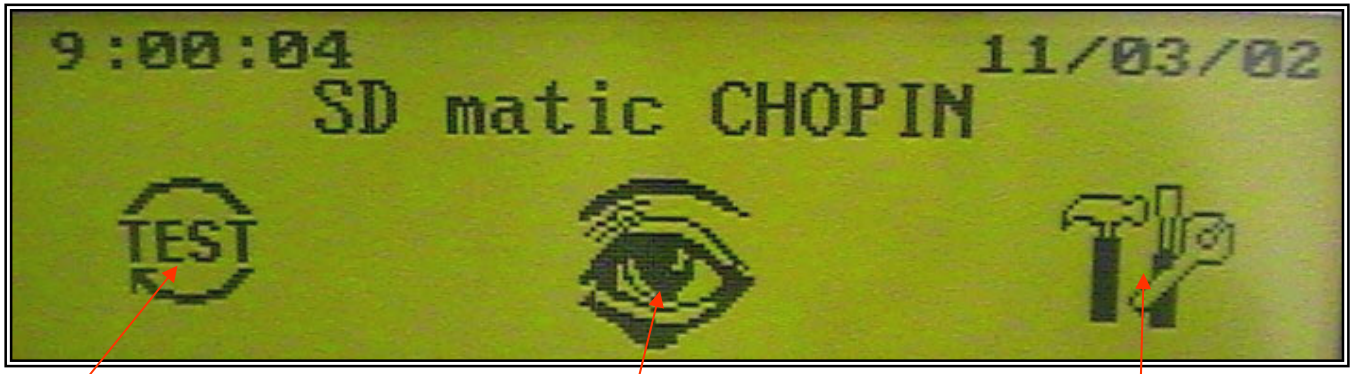
Heating of the sample

Electrode of measurement

Cleaning accessories

Reaction bowl

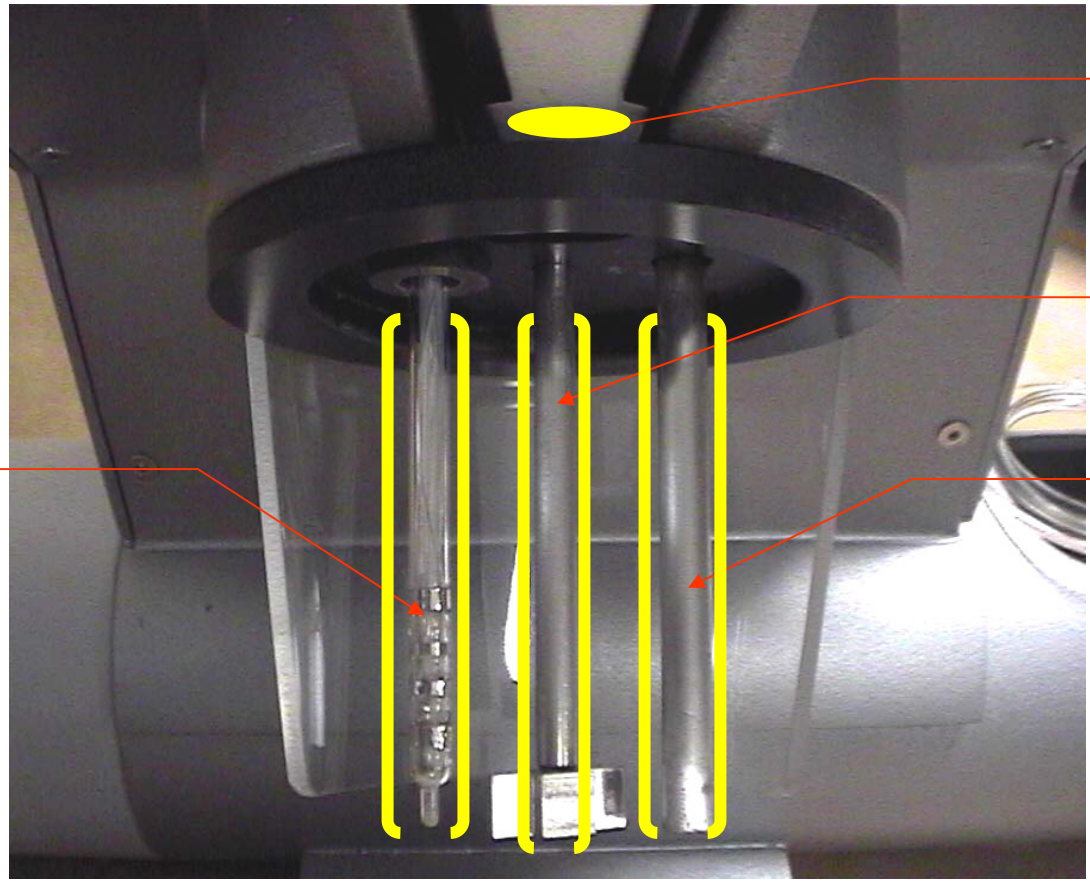
Informatic system
Sensitive Screen



Test | **Control** | **Maintenance**

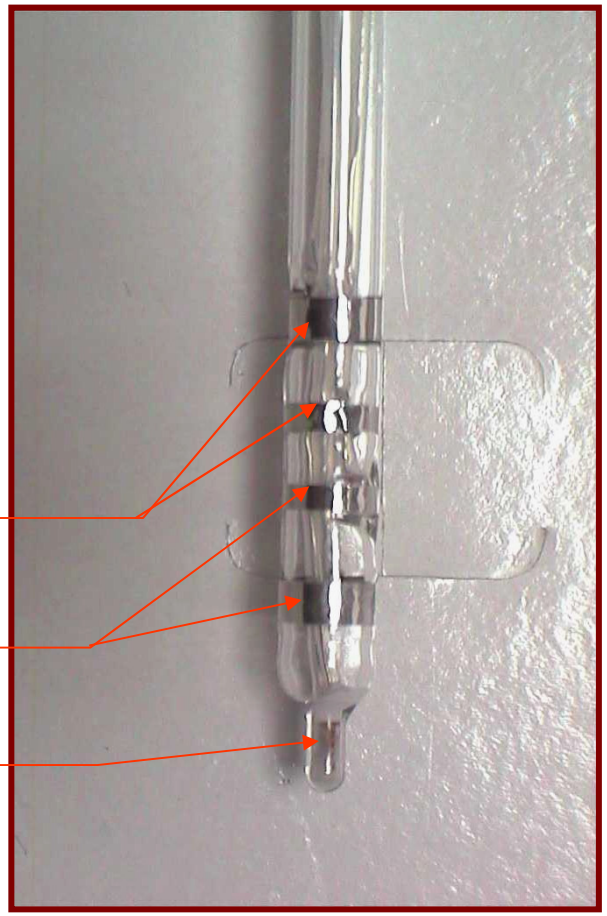
- User-friendly
- Tactile Screen
- Simple Menus
- Possible automatic control of the important parts

Electronic
Stirrer and heating resistor



Measuring Elements

The probe



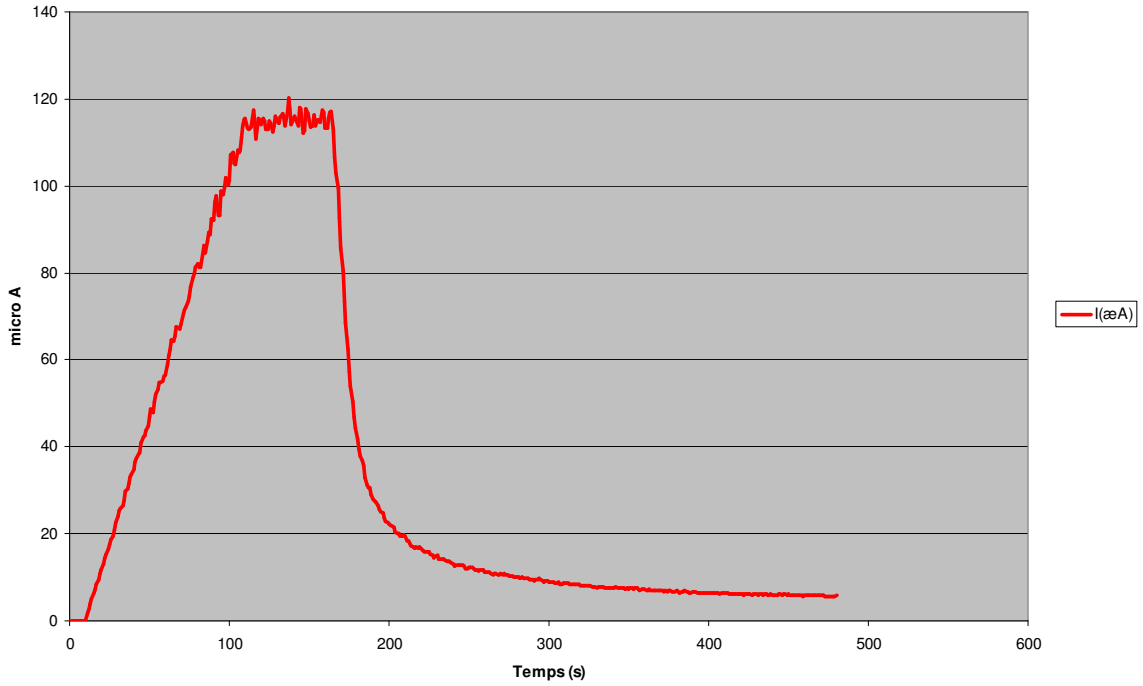
This new probe ensure 3 functions :

- **2 platinum electrodes de for the iodine generation.**
- **2 electrodes for the measurement of the iodine "absorbed" by the starch.**
- **1 temperature probe.**

Solution/Test : preparation

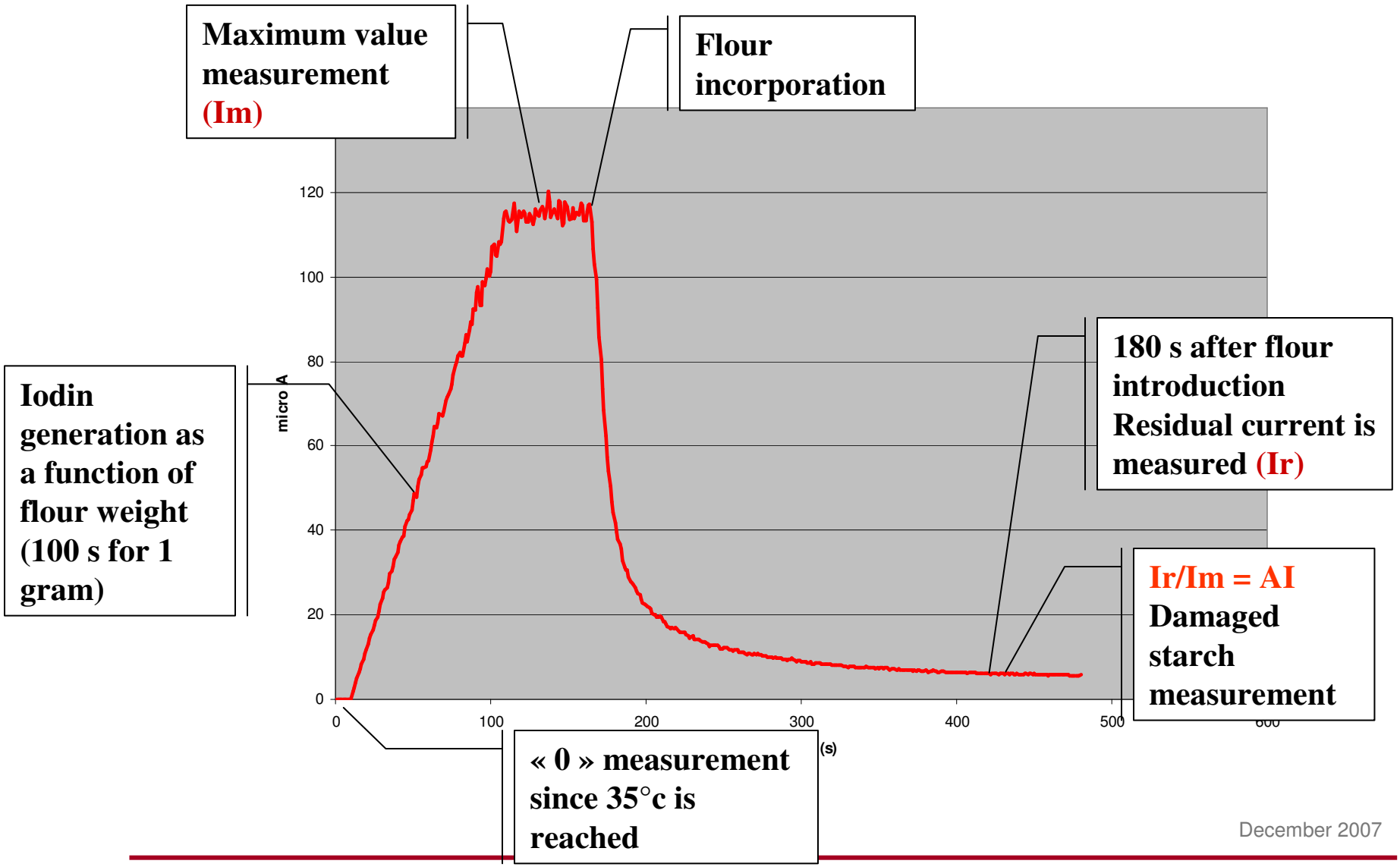
- **No preparation is required !!**
  - 120 ml of distilled water +/-0,1ml
  - 3 grams of Boric Acid (H_3BO_3) +/- 0,2 g
  - 3 grams of Potassium Iodide (KI) +/- 0,2 g
  - 1 drop of Sodium Thiosulphate
  - 1 gram of flour +/- 0,1g
- **No precise weighing is required !!**
- **No special qualification is required !!**
- **10 min test**
- **Automatic stop**

Measurement

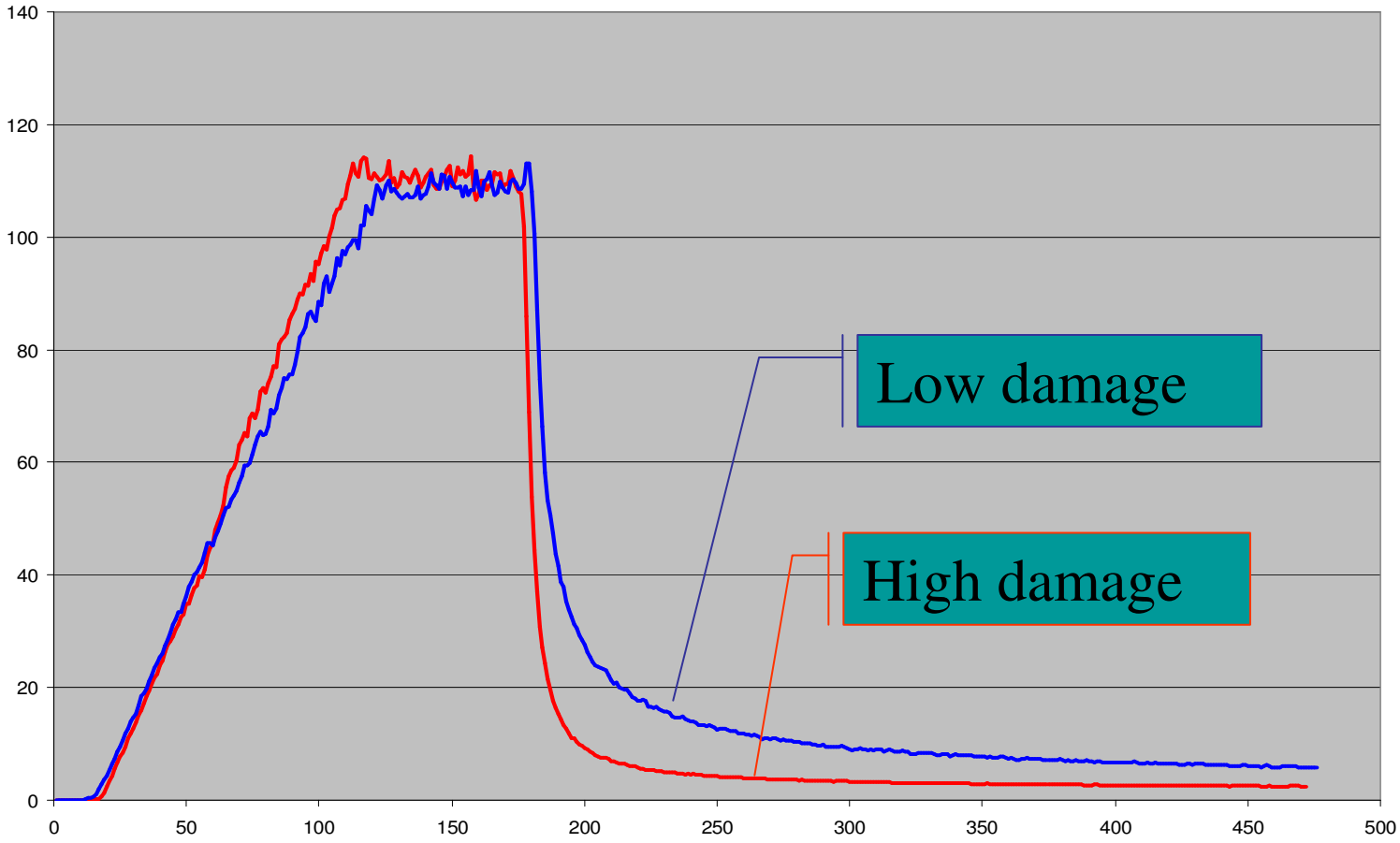


- At the end of the test, the SDmatic measures the residual current.
  - More damaged starch, more fixed iodine.
  - The residual current decrease.

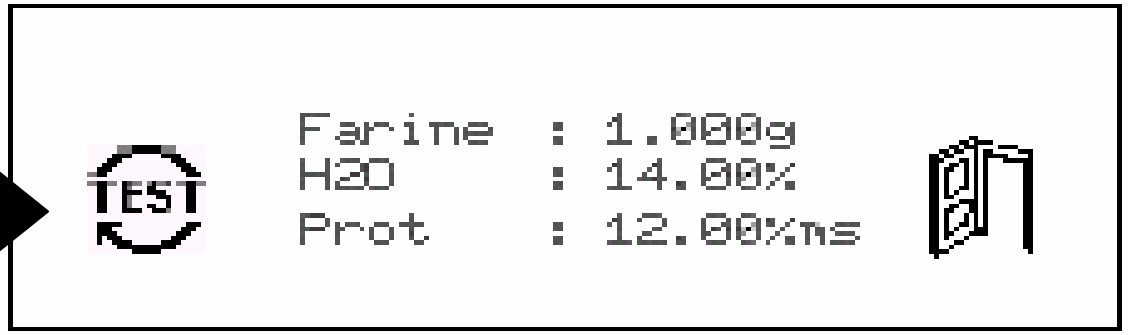
Measurement principle



Results Examples



Test Preparation



1 gram of flour +/- 0,1g

- Quick Preparation
- It does not require qualification
- Quick Test (10min.)
- Automatic Stop.
- At the end of the test, the SDmatic measures the residual current.

More damaged starch, more fixed iodine.
The residual current decrease.

Comparison with the enzymatic methods

Method	Range of values normally found.	Precision of the method
SDmatic	**12 - 28 UCD**	**+/- 3%**
FARRAND	10 - 45 units	+/- 9%
AUDIDIER	10 - 18 %	+/- 7%
AACC	4 - 9 %	+/- 11%

Conclusions

1/ The damaged starch

2/ The milling
Industrial
Laboratory

3/ Effects on final products.

4/ comparative results & interpretations.

5/ Methods for its measurement.

6/ Description of a new method

7/ Conclusions.

The damaged Starch

Can not be avoid during the milling process.
Can be controlled at the mill level.

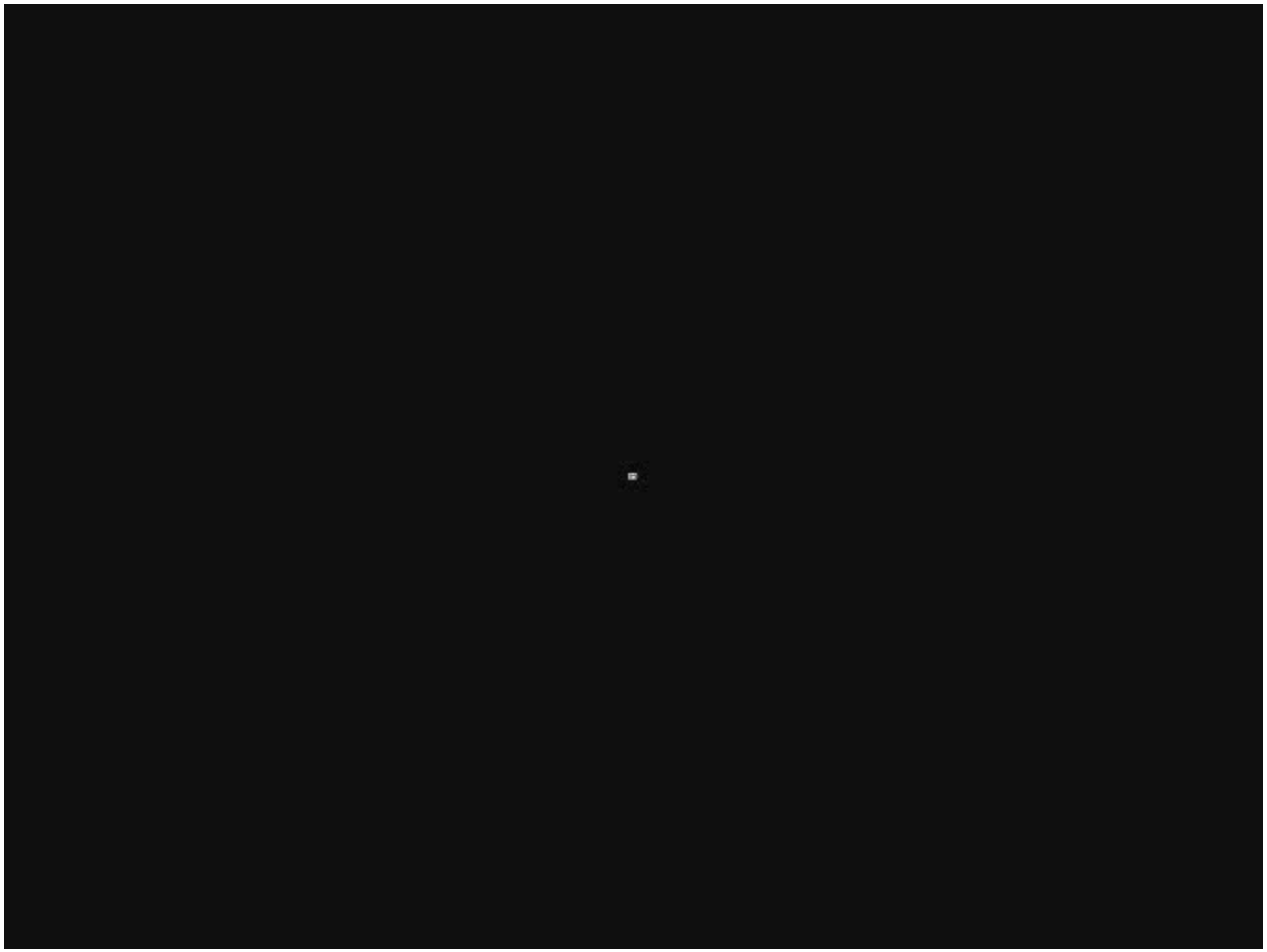
Have a positive influence on the water absorption.
Can lead to disastrous results during bread making.

Enzymatic methods are not simple.
However, it is necessary to find the optimum level for each bread making process.

Conclusions

- The Amperometric Method is a standard N° AACC 76-33 & ICC 172
- Simple and Quick preparation
- Accurate Measurement in less than 10min.
- Automatic Measurement.
- Does not require high qualification.

Thank you for your Attention



Questions ?