Flour Improvement Update

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Selected Topics

- Sprout-damaged flour
- Gluten enhancement
- Bug-damaged flour
- Noodle flour improvement
- Enzymes: carboxyl esterases
- Outlook: enzymatic bleaching

Sprout Damage

Sprouted wheat, harvest 2010, Germany

D. Nolte, Aug. 2010

Reasons for High α-Amylase Activity

- **Sprout damage due to excessive rain falls prior to harvest →**
  - **hidden**
  - **obvious sprouting**
- **Late frost on immature wheat heads →**
  - **“green amylase” not re-metabolized**
  - **no visible sign for sprout damage**

Sprout Damage – Effects

- **Falling number, gelatinization temperature, maximum viscosity too low**
- **Insufficient water absorption**
- **Sticky doughs**
- **Weak dough structure**
- **Excessive browning**
- **Coarse pore structure**
- **Crumb structure with lower elasticity**
- **Good shelf-life of crumb softness**

Sprout Damage - Principal Measures

In the flour mill

- Lower extraction rates
- Keep starch damage as low as possible

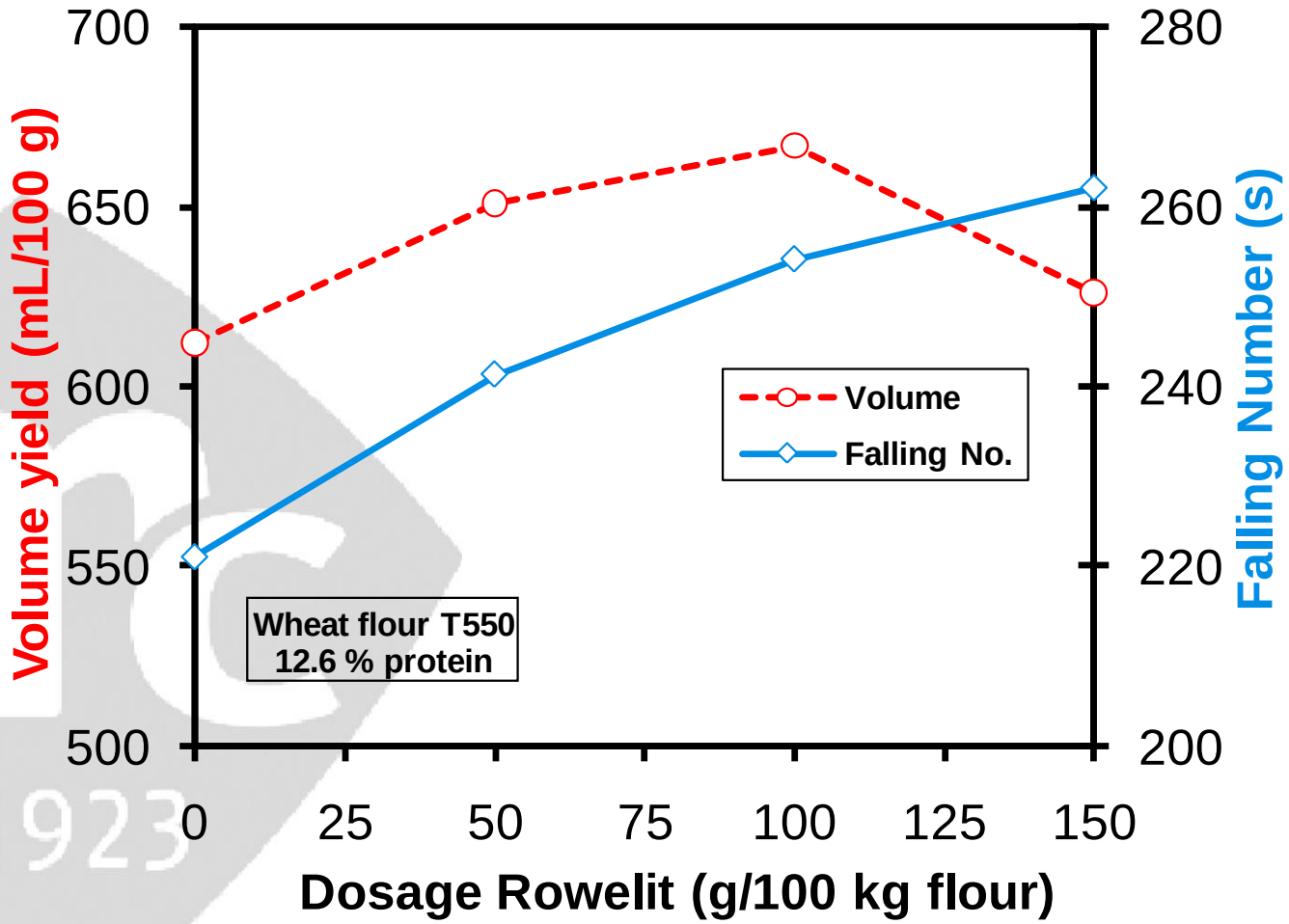
In the bakery

- Increase acidity by sour dough or acidifiers
- Prepare stiffer doughs
- Reduce energy input upon kneading
- Reduce bench time (safe time for final proof)
- Reduce bread improvers with strong enzyme activity
- Slightly increase sodium chloride, if possible

Flour Treatment in Case of Sprout Damage

- **Oxidation & maturing agents (e.g. ascorbic acid)**
  - **Increase significantly**
- **Enzymes**
  - **Reduce dosage of amylase**
  - **Cautious use of xylanase**
  - **Consider oxidase**
- **Emulsifiers (Datem, mono/di, lecithin)**
  - **Help to reduce stickiness**
  - **Improve dough stability**
- **Enzyme regulators**
  - **Help to control effect of intrinsic enzymes**

Effect of Enzyme Regulator Rowelit on Falling Number and Volume Yield



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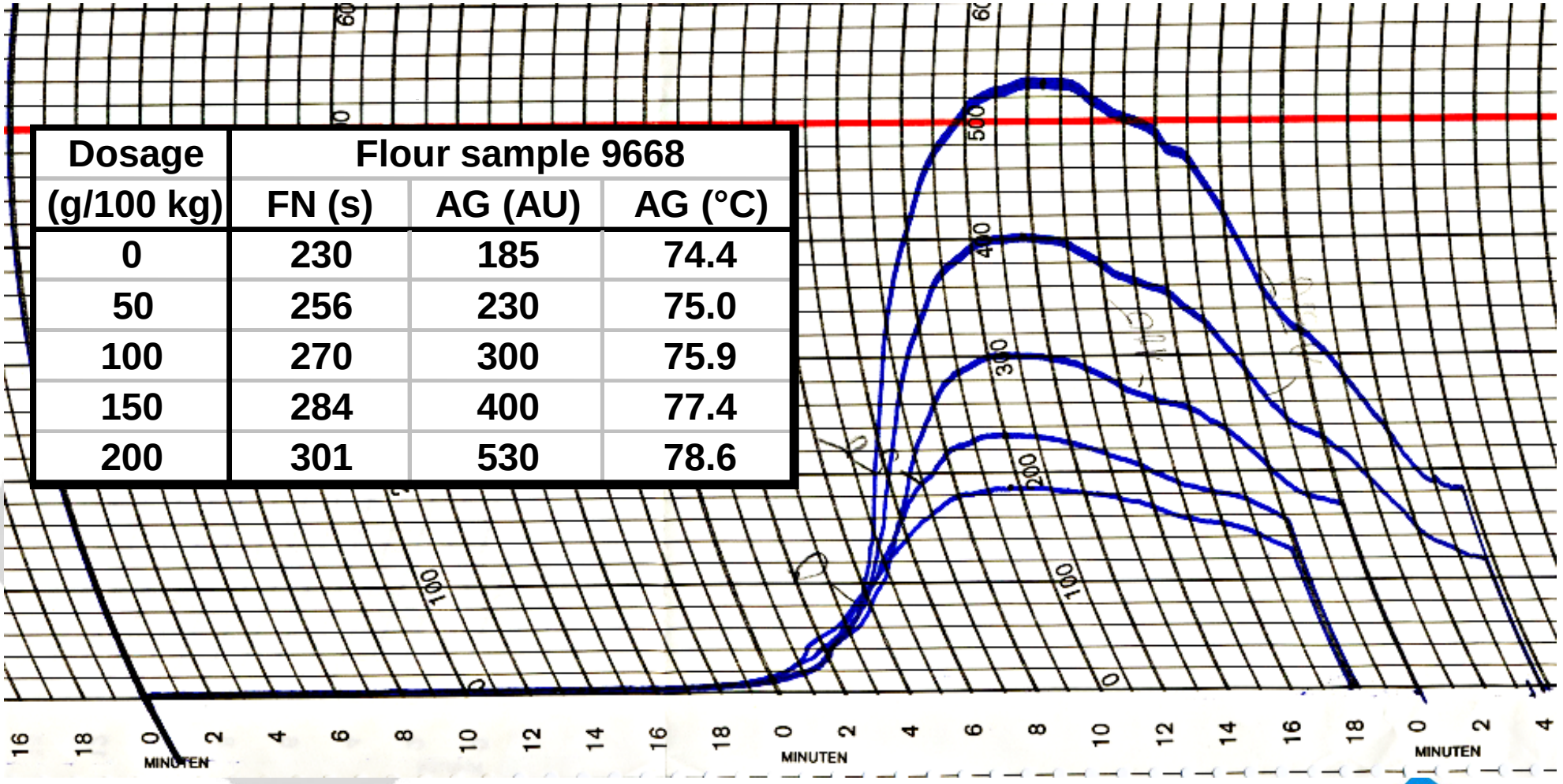
Effect of ROWELIT on Wheat Flour Amylograms

Dosage	Flour sample 9668		
(g/100 kg)	FN (s)	AG (AU)	AG (°C)
0	230	185	74.4
50	256	230	75.0
100	270	300	75.9
150	284	400	77.4
200	301	530	78.6



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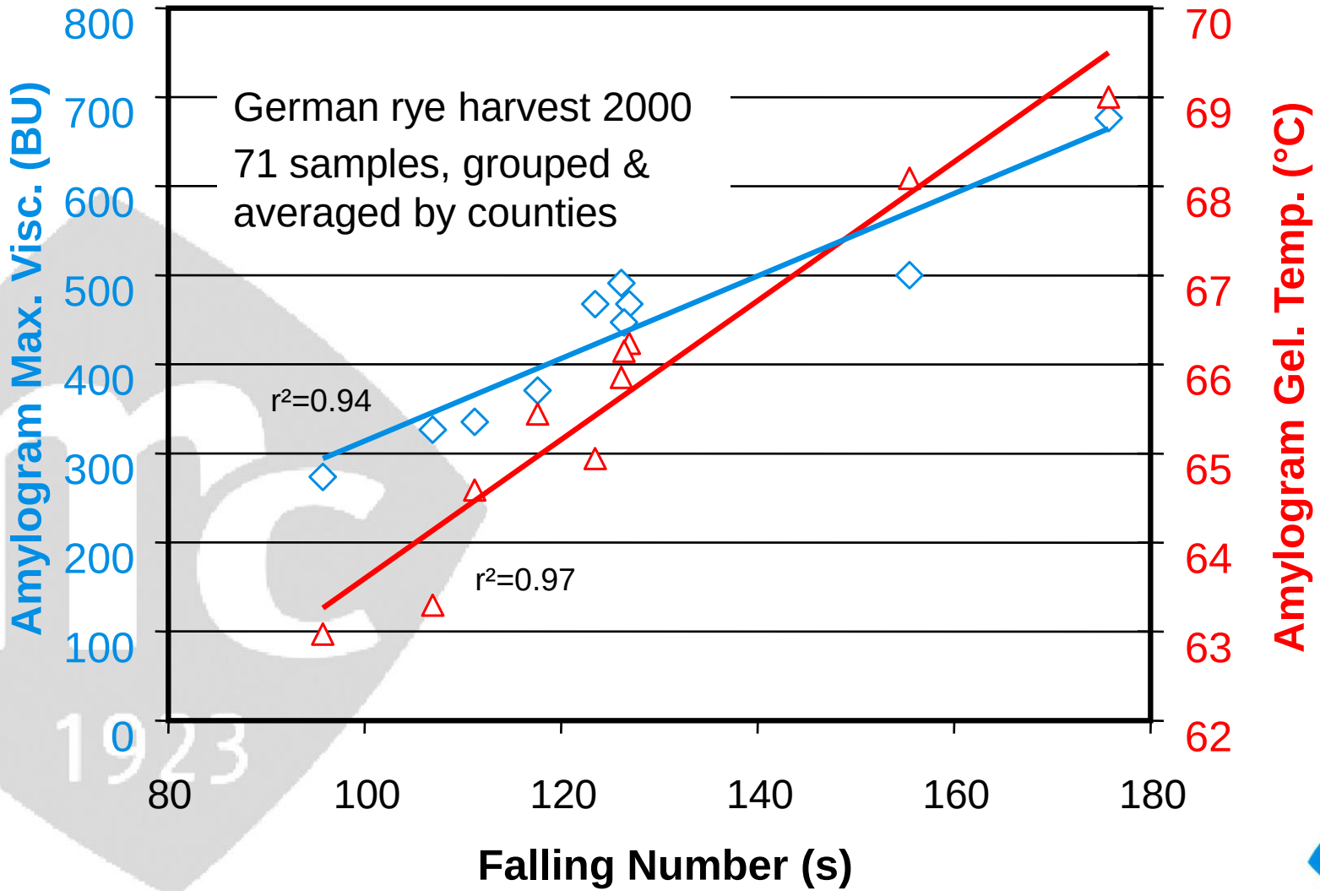
Correlation of Falling No. & Amylogram



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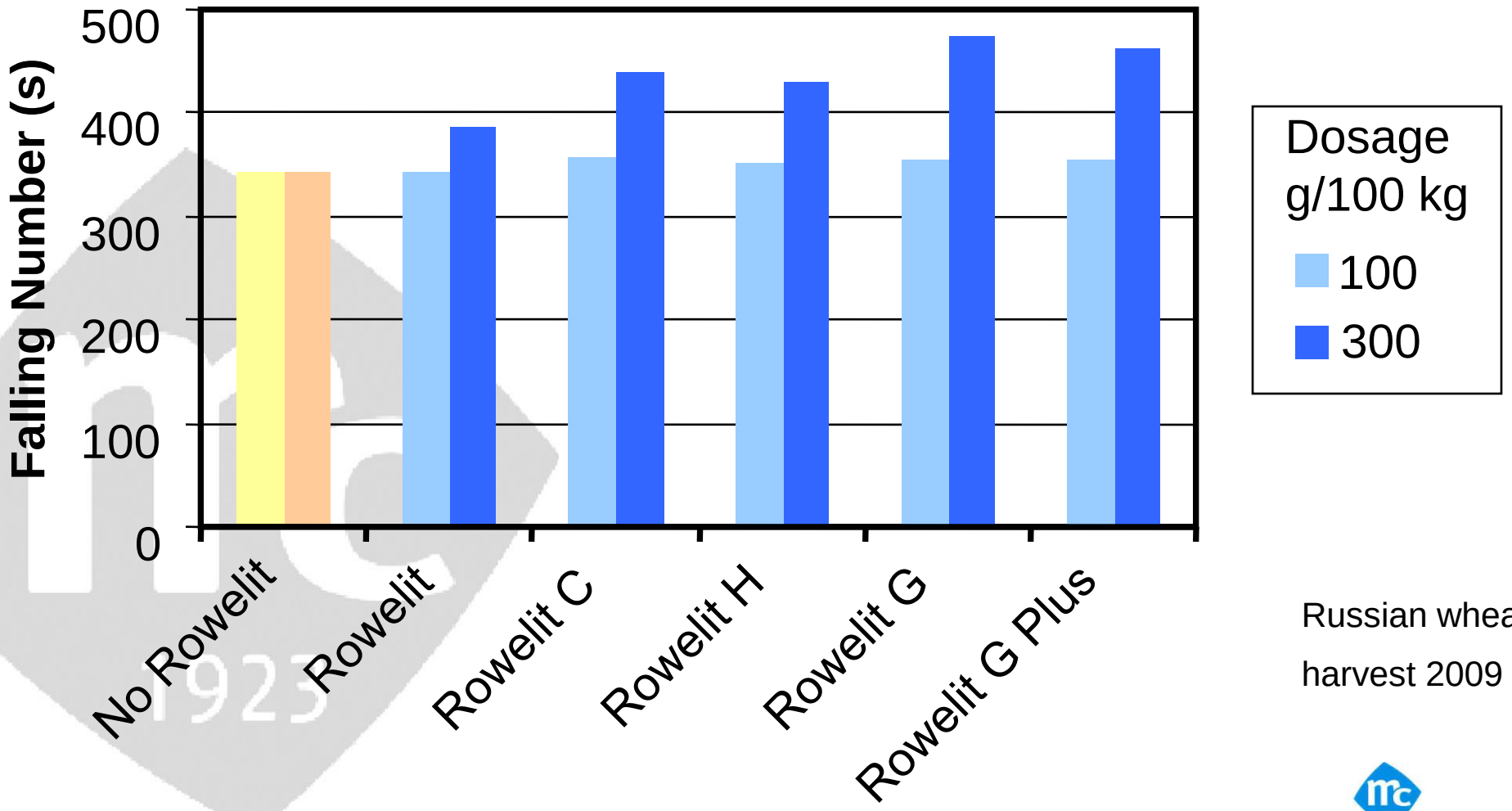
Effect of Rowelit Variants on the Falling Number



Russian wheat, harvest 2009

Gluten Enhancement

Low-Protein Flour – Reasons & Effects

Reasons

- **Wheat variety**
- **Growth conditions**
- **Fertilization**

Effects

- **Low extensibility**
- **Little tolerance**
- **Reduced volume yield**

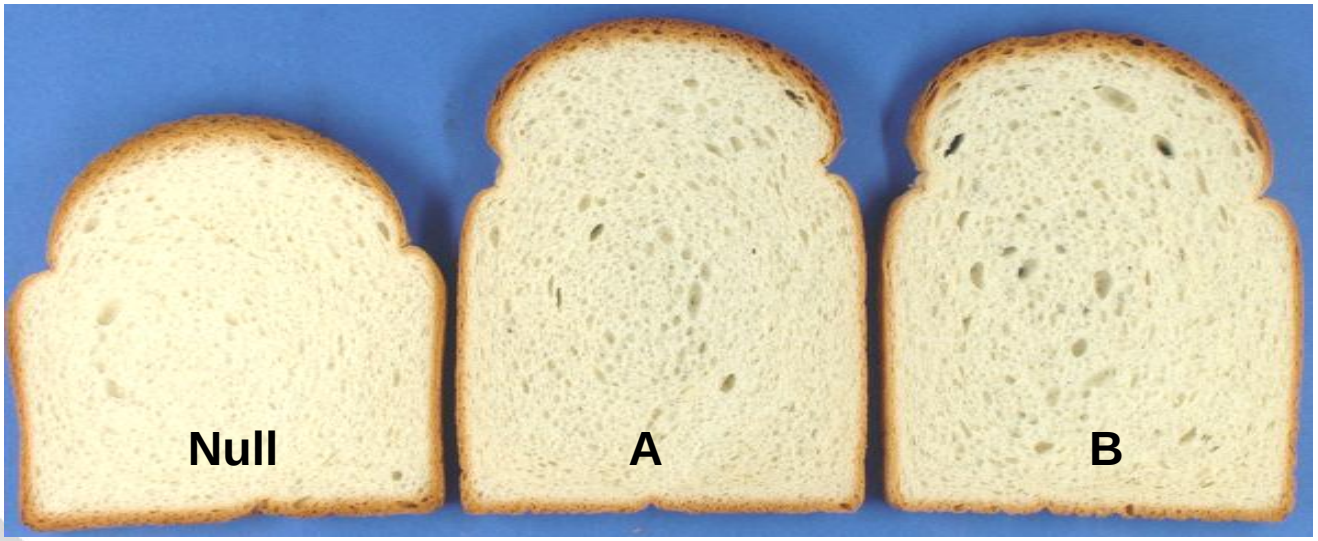
Low-Protein Flour – Measures

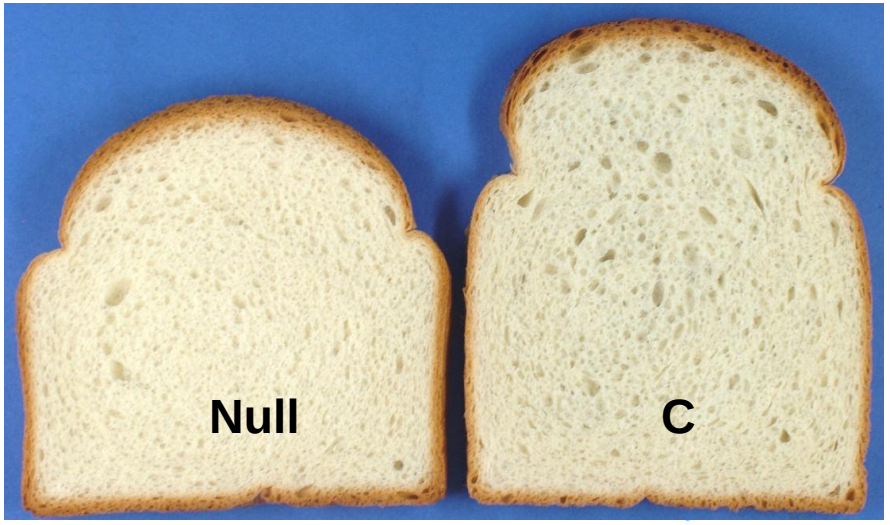
- Blending
- Air classification
- Finding the best application
- Gluten addition
- Stabilization of the gluten
  - Oxidative treatment
  - Enzymes
  - Emulsifiers
  - Minerals and salts
  - Synergistic proteins & polymers

Gluten Enhancer – US Sandwich

Basic treatment

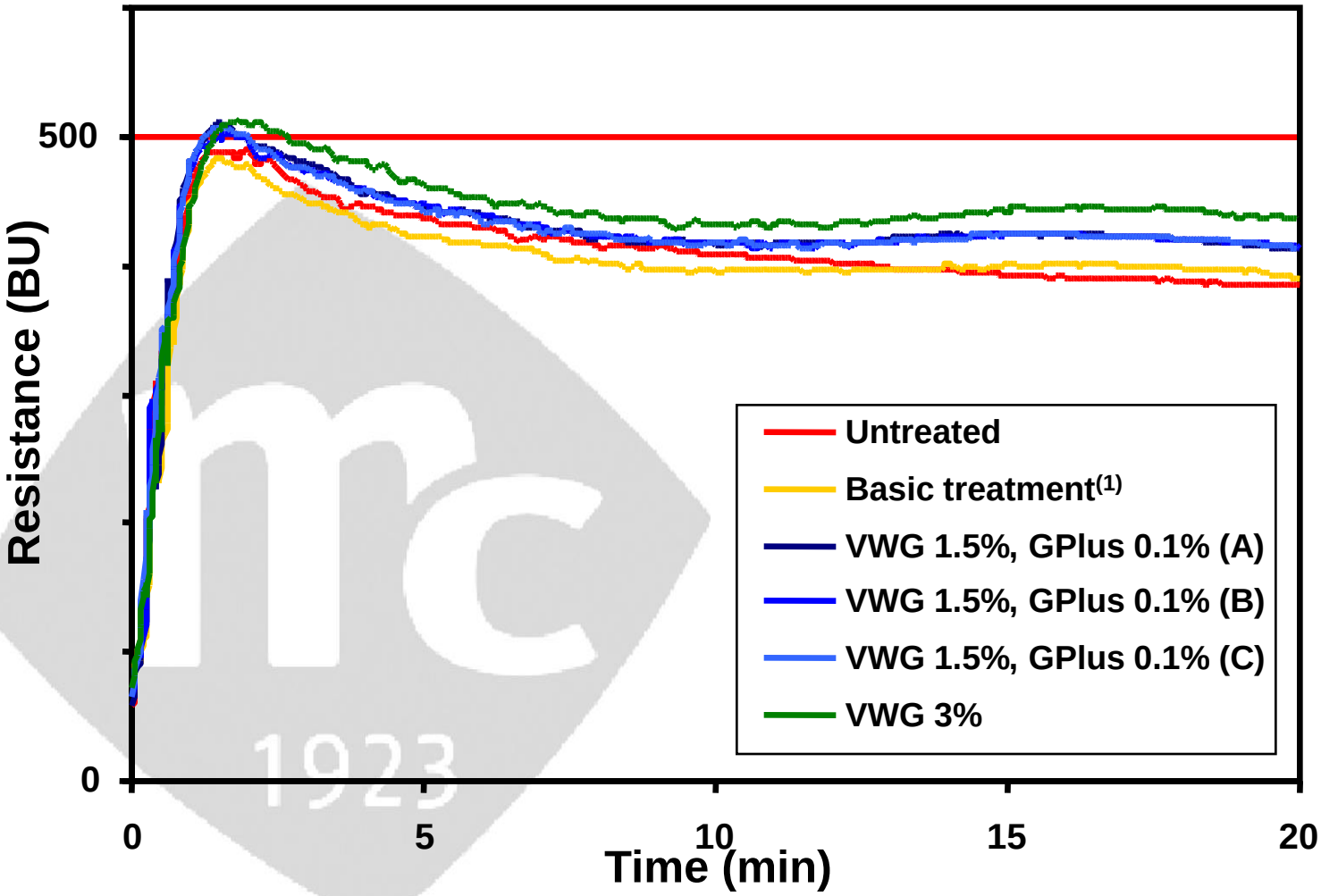
BX	350 ppm
SSL	4,000 ppm





Sample No.	Null	A	B	C
EMCEvit C (%)	-	3	1.5	-
EMCEgluten^{Plus}(%)	-	-	0.08	0.10
Vol. yield (ml/100 g flour)	840	910	920	910
Costs (USD/t flour)		83.2	47.9	10.9

Farinographs with EMCEgluten^{Plus} Gluten Enhancer – Basic Treatment: SSL and Alphamalt BX



(1) Basic flour treatment:
SSL, 4,000 ppm
Alphamalt BX, 350 ppm

GPlus=EMCEgluten^{Plus}

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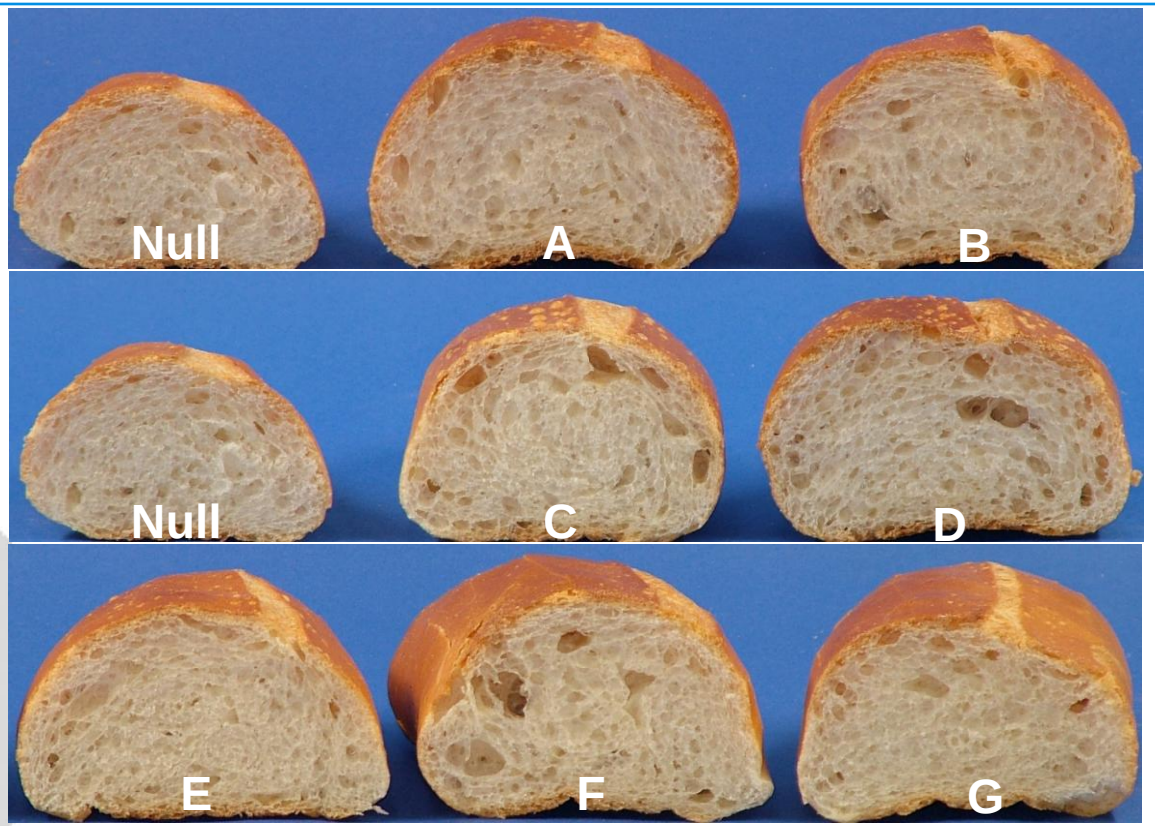
Gluten Enhancer – Venezuela Baguette, 16-19 h Fermentation, 10% Protein

Basic treatment

Oxem 100[(1)] 40 ppm
C 100-K[(2)] 20 ppm
A 14888[(3)] 150 ppm



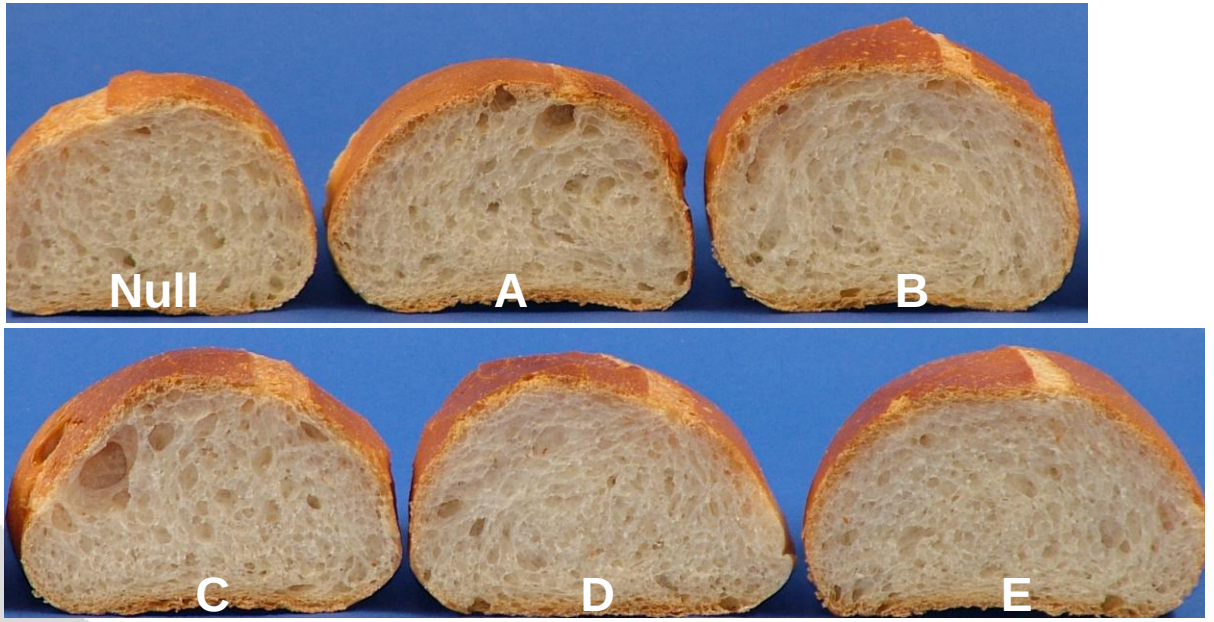
(1) Azodicarbonamide
(2) Ascorbic acid
(3) Enzyme compound
(4) Vital wheat gluten
(5) Gluten enhancer

Sample No.	Null	A	B	C	D	E	F	G
EMCEvit C[(4)] (%)	-	3	1.5	1.5	0.75	-	-	-
EMCEgluten[Plus] [(5)] (%)	-	-	0.08	-	0.04	0.10	0.20	0.30
Vol. yield (ml/100 g flour)	550	690	680	620	650	685	750	800
Costs (USD/t flour)		81.8	49.6	40.9	20.9	10.9	21.8	32.7

Gluten Enhancer – Venezuela Baguette, 16-19 h Fermentation, 12% Protein

Basic treatment

Oxem 100[(1)] 40 ppm
C 100-K[(2)] 20 ppm
A 14888[(3)] 150 ppm



(1) Azodicarbonamide
(2) Ascorbic acid
(3) Enzyme compound
(4) Vital wheat gluten
(5) Gluten enhancer

Sample No.	Null	A	B	C	D	E
EMCEvit C[(1)] (%)	-	3	1.5	-	-	-
EMCEgluten[Plus (5)](%)	-	-	0.08	0.10	0.20	0.30
Vol. yield (ml/100 g flour)	580	635	730	670	700	750
Costs (USD/t flour)		81.8	49.6	10.9	21.8	32.7

Gluten Enhancer Benefits

- Dosage only 400 – 3,000 ppm
- Can replace 50% and more of added gluten
- Upgrades low protein flour
- Boosts vital wheat gluten function
- Does not interfere with standard flour treatment or bread improvers
- Improves rheological and baking properties
- Lable-friendly

Bug-Damaged Flour

Bug-Damaged Flour – Culprits 1 (Sunn Pest)


Eurygaster sp.


Eurygaster sp.


Gregarius sp.

www.uvm.edu/~entlab/sunnpest

Bug-Damaged Flour – Culprits 2 (Sunn Pest)

Aelia sp.

www.uvm.edu/~entlab/sunnpest

Nysius sp.

Howard F. Schwartz

Hikmet Boyacioglu

Bug-Damaged Wheat Kernels

Source: Peter Cate, AGES Vienna

Bug-Damaged Flour – Reasons

- **Infestation on the field - Sunn pest**
  (Eurygaster integriceps, Eurygaster maura,
  Aelia acuminata, Aelia rostrata, Nysius huttoni)
- **Secretion of digestive enzymes into the grain (and into the stem ?)**
- **Gluten degradation during dough preparation**

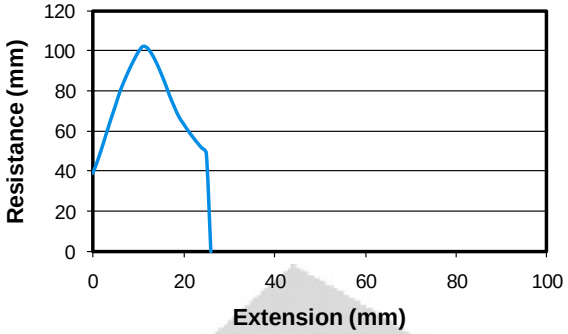
Bug-Damaged Flour – Effects (1)

- **Wheat grain: almost invisible dark spots (punctures) surrounded by lighter circles**
- **Some grains shriveled or lighter, but hectoliter weight mostly unchanged**
- **Falling number normal**
- **Sedimentation almost normal**

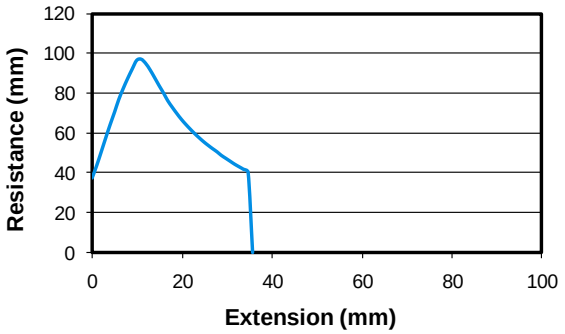
Bug-Damaged Flour – Effects (2)

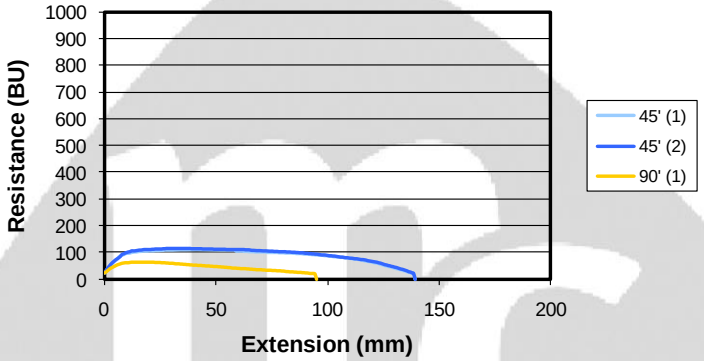
- Gluten index lower, close to normal
- Swelling index lower
- Extracted gluten liquefies upon resting
- Farinograph: very low stability, narrow curve
- Sticky & runny doughs with low resistance
- Low baking performance
- Bitter taste

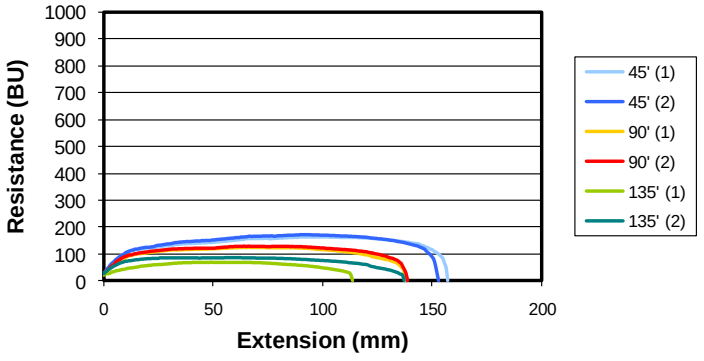
Bug-Damaged Flours – Rheology

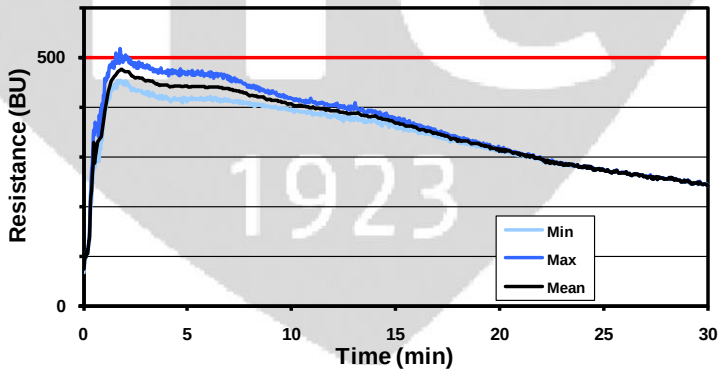


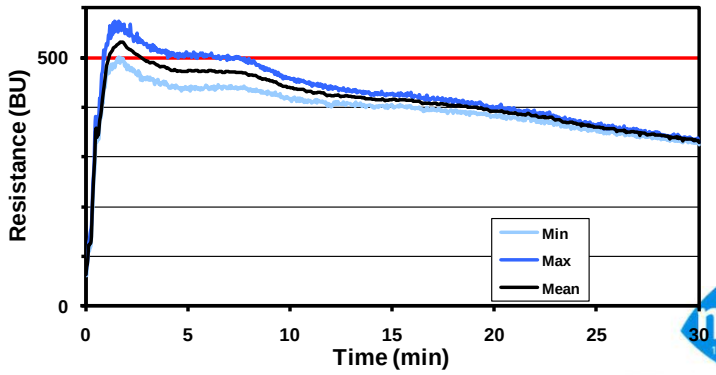
Romania, harvest 2009



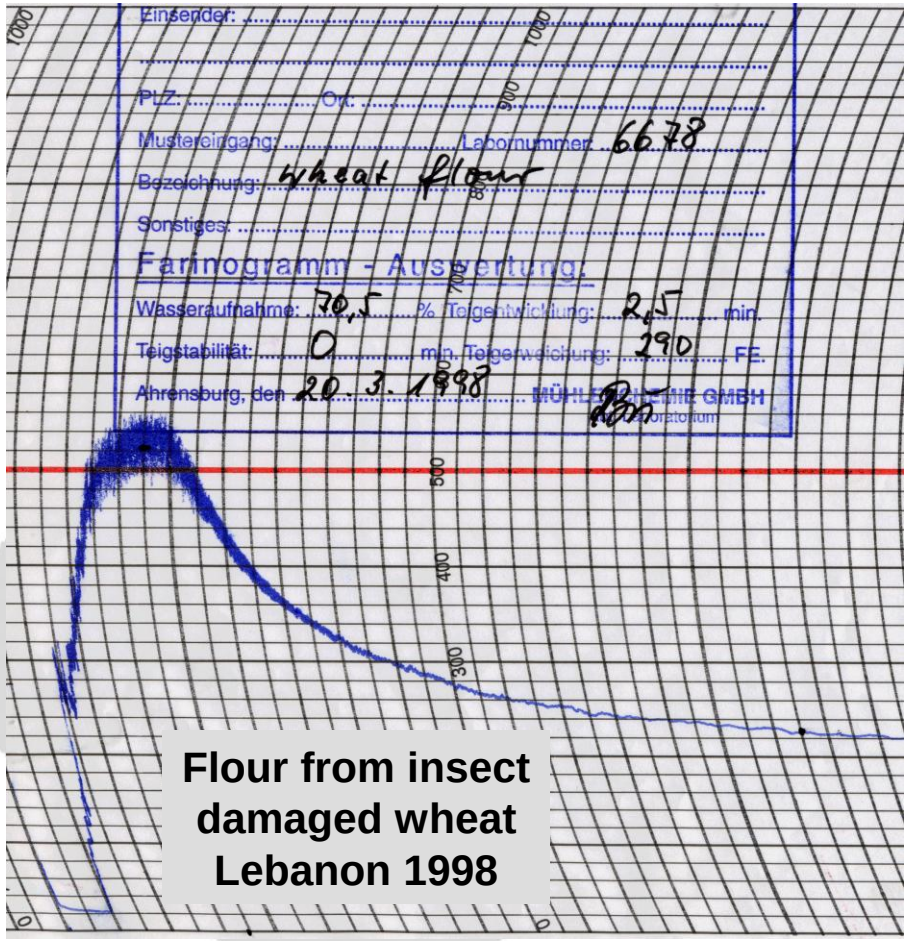




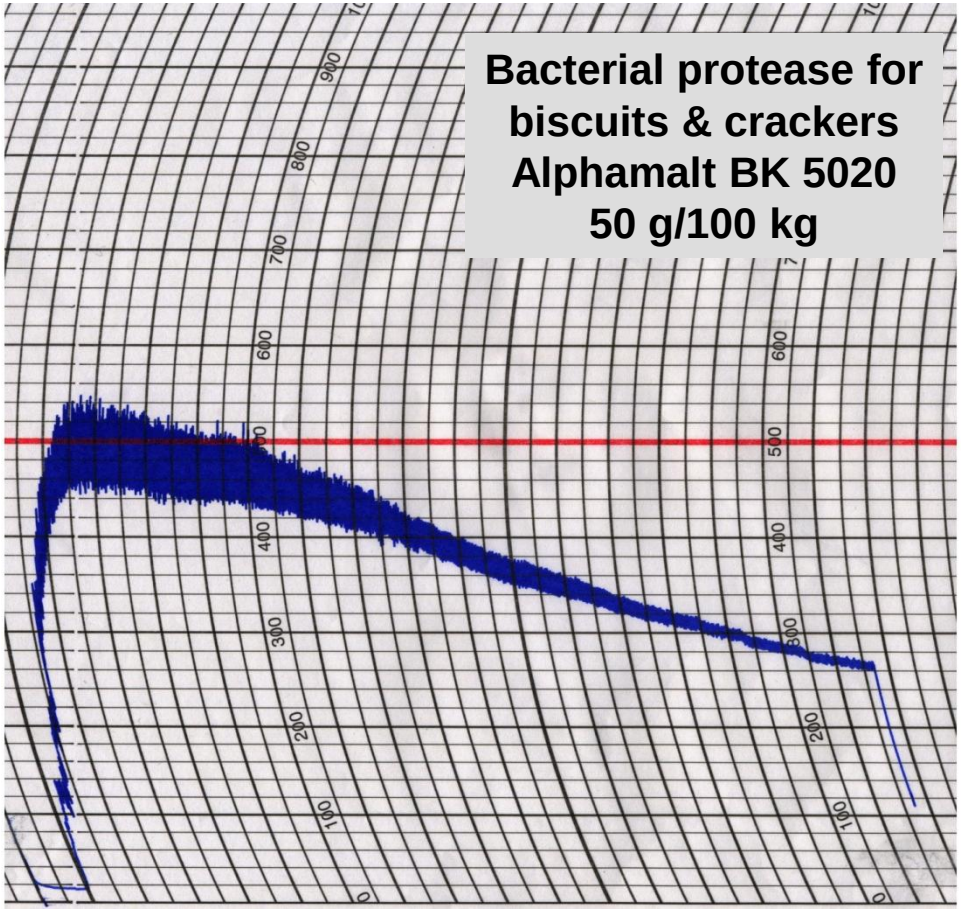




Comparison of Bug-Damaged with Protease-Treated Flour in the Farinograph



Flour from insect damaged wheat Lebanon 1998



Bacterial protease for biscuits & crackers Alphamalt BK 5020 50 g/100 kg

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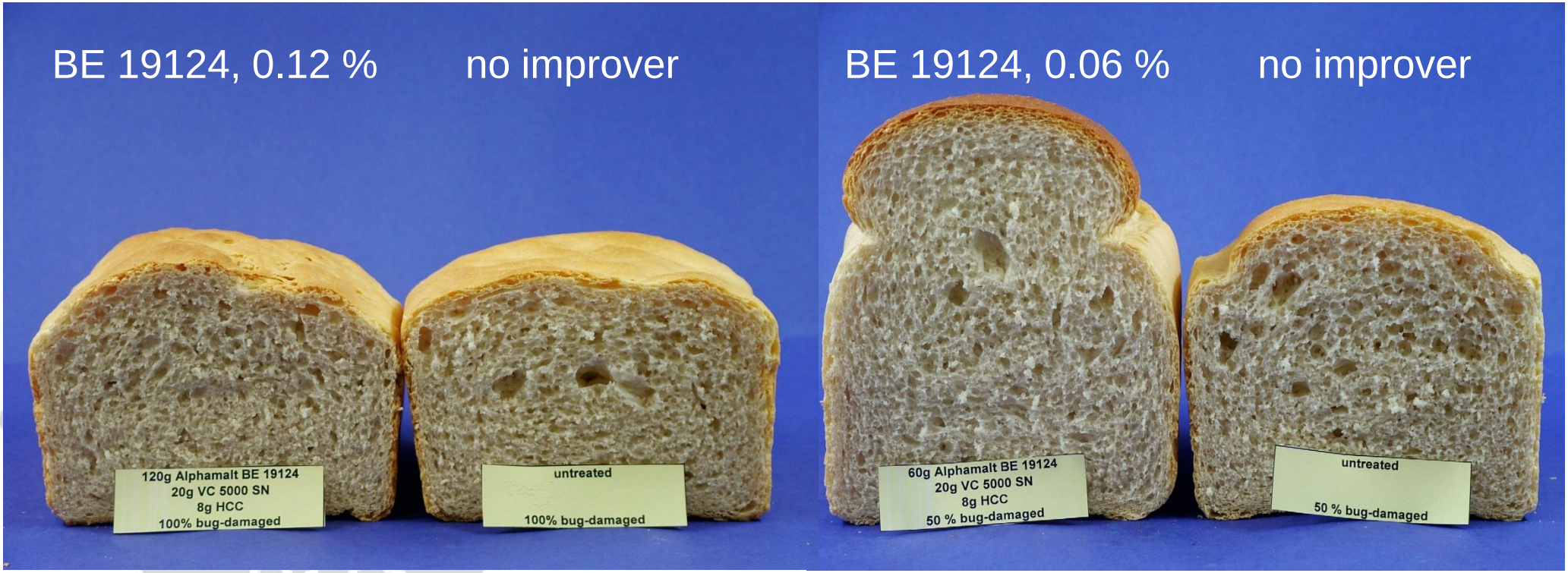
Bug-Damaged Flour – Measures

- **Conditioning at increased moisture & temperature (?*)**
- **Blend with sane flour but reduce damaged part to a minimum**
- **Reduce dough resting times to a minimum**
- **Use improvers that**
  - **a) strengthen the gluten**
  - **b) block the insect enzymes**
  - **c) improve overall baking properties**
- **Choose suitable application: e.g. biscuits, crackers or wafers**

* e.g. Berlin, E. 1936. Die Mühle, 73(5), 129-130, or Kretovich, VL, 1944. Cereal Chem. 21(1), 1-17

Reducing the Effects of Bug Damage (1)

Alphamalt BE 19124: Enzymes, maturing agents



100 % bug-damaged flour

50 % bug-damaged flour
50 % sound flour

Wheat flour T800, Romania, harvest 2009

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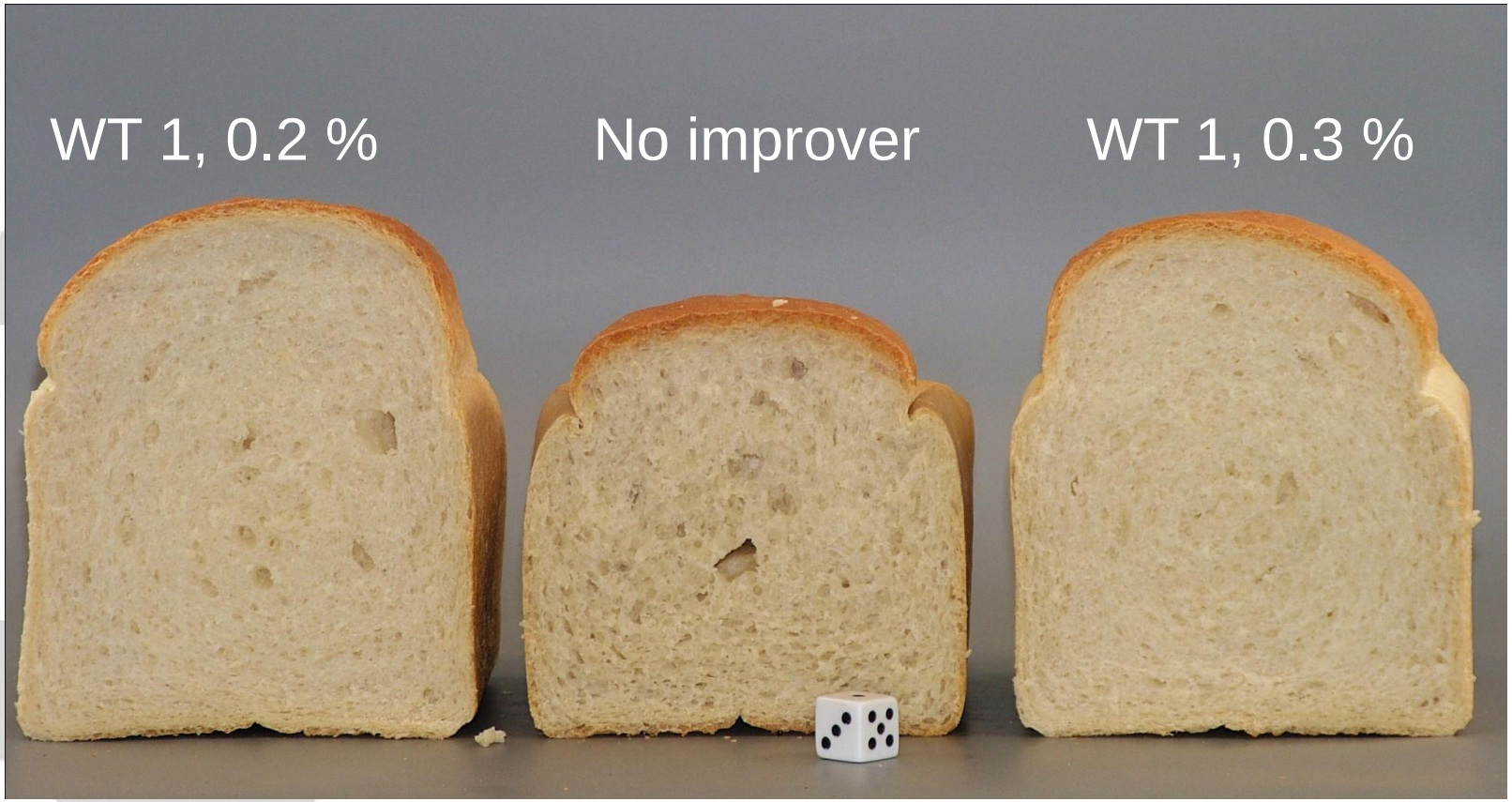
Reducing the Effects of Bug Damage (2)

Alphamalt WT 1: Enzymes, ascorbic acid, pH control

Wheat flour T550, Romania, harvest 2010

Reducing the Effects of Bug Damage (3)

Alphamalt WT 1: Enzymes, ascorbic acid, pH control



Wheat flour T550, Bulgaria, harvest 2010

Noodle Flour Improvement

Desirable Properties for Noodle Flour

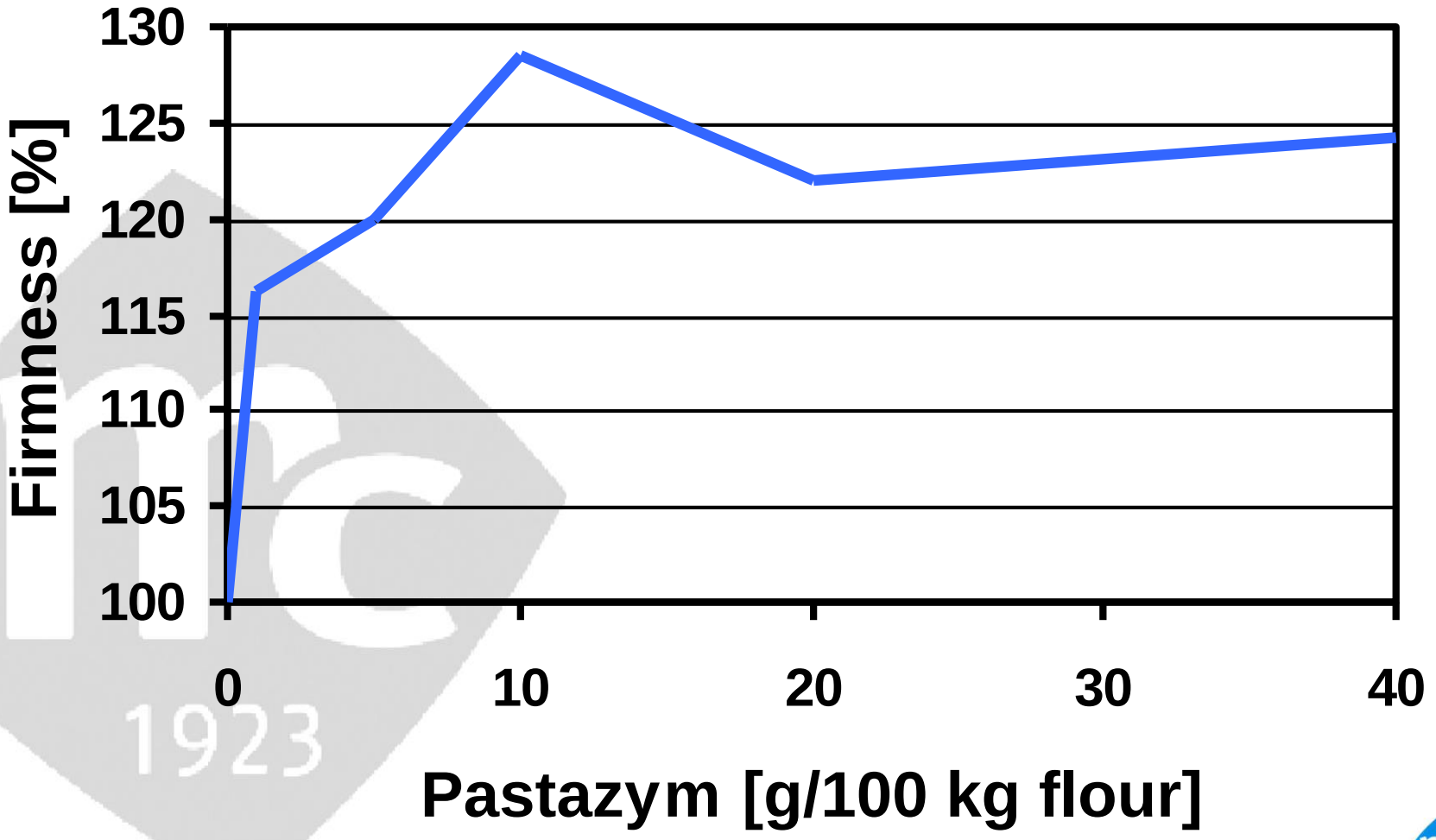
- Easy processing
  - soft & extensible dough required
- Uniform & quick drying
  - low water absorption
- Tolerance towards moisture from fillings
  - firm and closed (uniform) dough structure
- Low leaking losses upon cooking
  - firm and closed (uniform) dough structure
  - low starch damage
- High cooking tolerance (low "soakiness")
  - firm and closed (uniform) dough structure
  - low starch damage
  - good protein quality

Pastazym

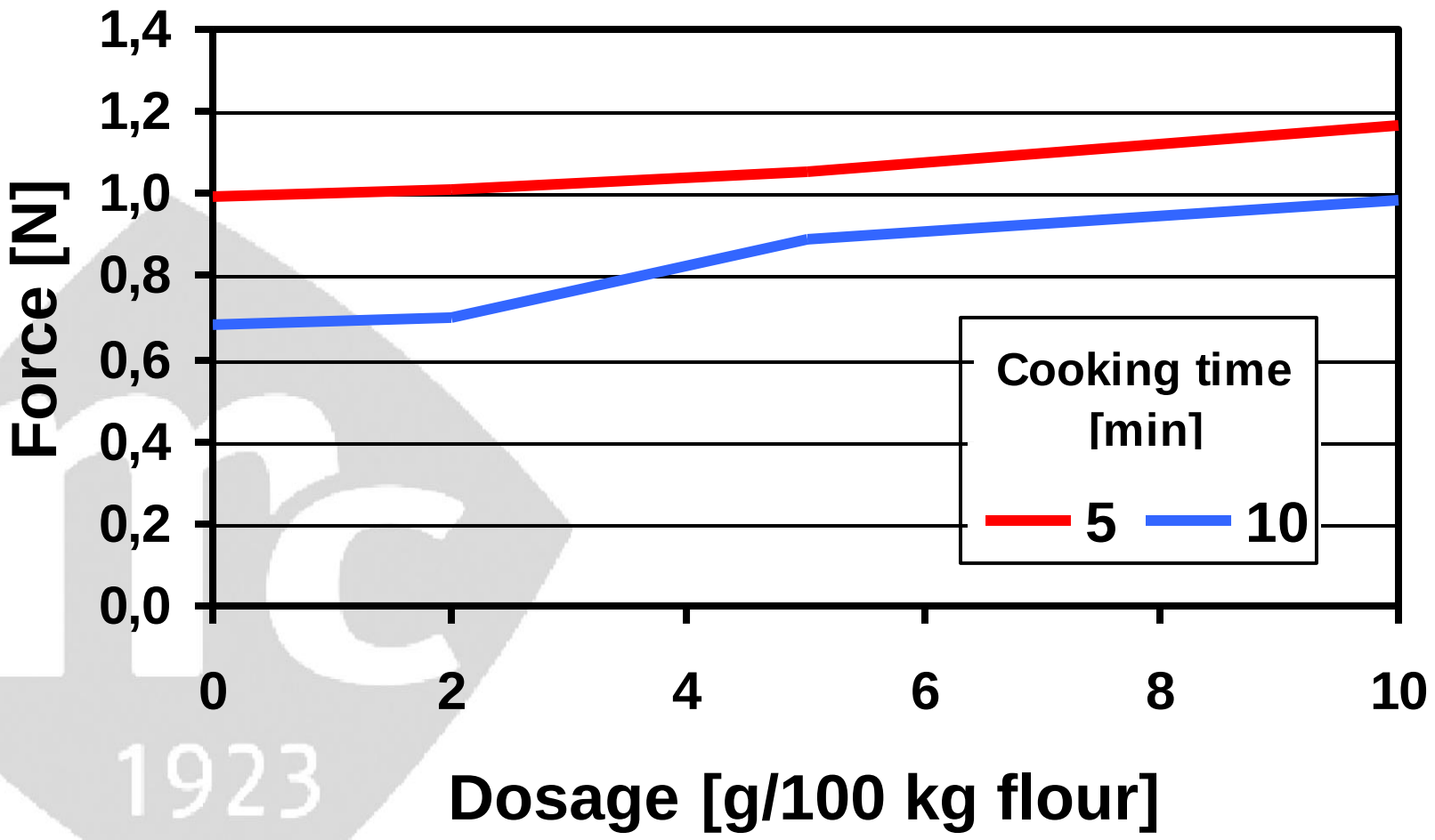
Advantages of Pastazym for Noodles

- **Improves color and brightness of dry and cooked noodles**
- **Increases firmness of cooked noodles**
- **Enhances overcooking tolerance**
- **Reduces oil uptake of fried instant noodles**
- **Reduces drying time of noodles**
- **Improves surface appearance**
- **Enhances mechanical stability of dried noodles**
- **Reduction raw material costs**

Firmness of Fresh, Uncooked Noodles



Improvement of Over-Cooking Tolerance with Pastazym

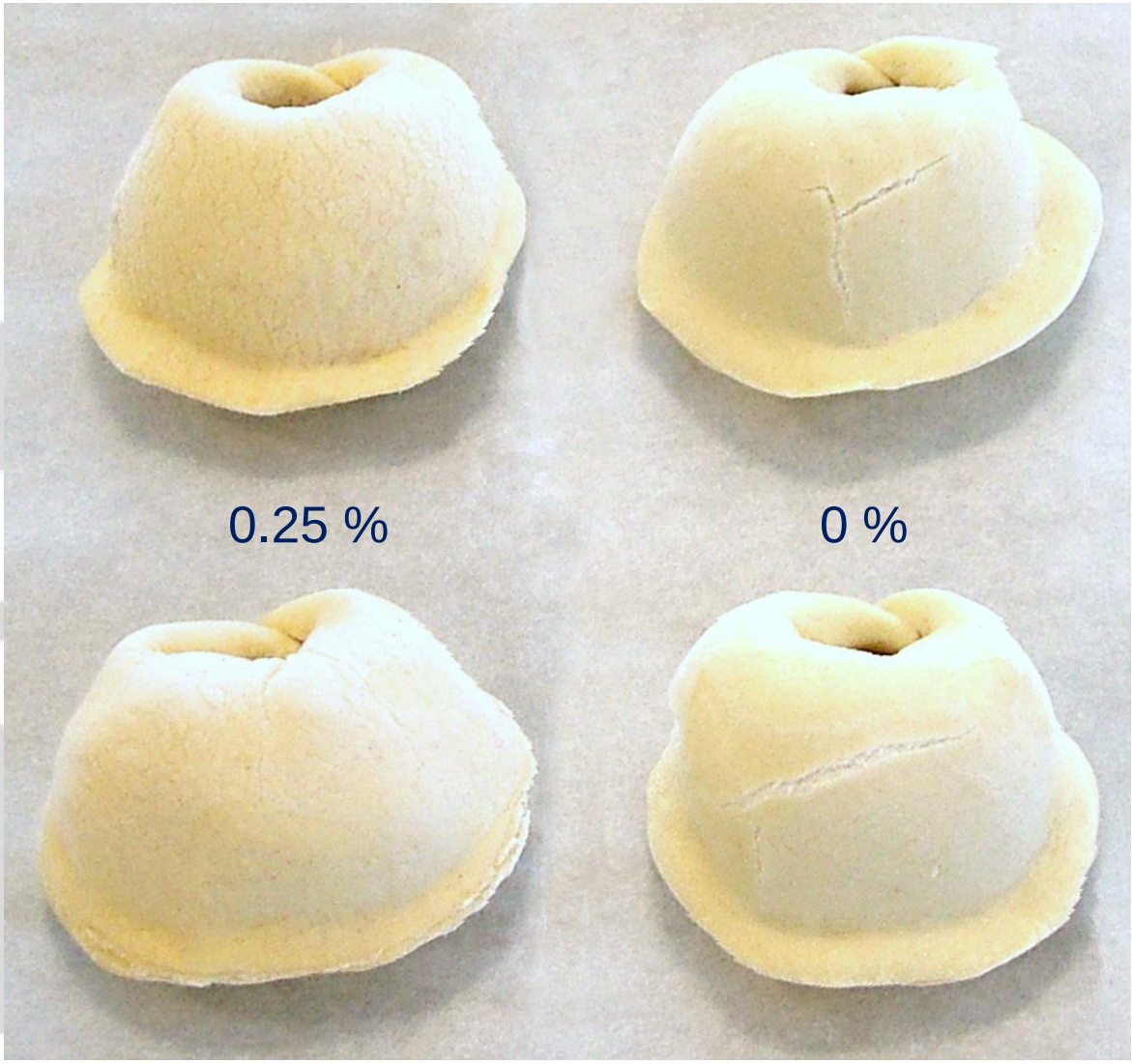


Mulgaprime 90F - Flour-grade Destilled Monoglyceride for Noodle Improvement

Advantages of Mulgaprime 90F

- Improves dough handling properties
- Enhances tolerance towards drying-out
- Strengthens dough structure of fresh noodles
- Improves the tolerance towards moisture from fillings
- Reduces crack formation
- Increases cooking tolerance

Effect of Mulgaprime 90F on Pelmeni Structure

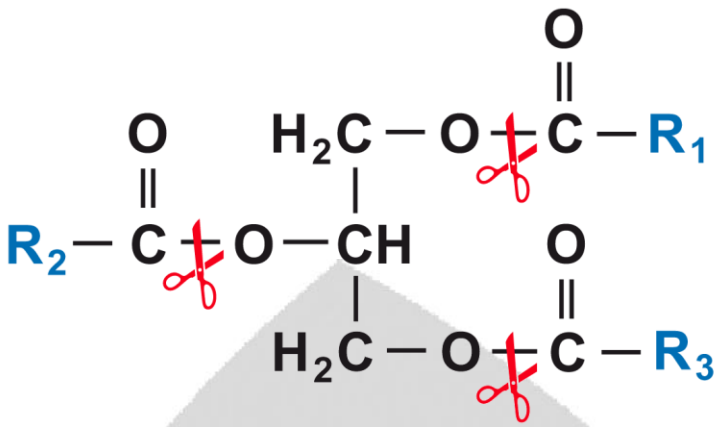


Enzymes: Carboxyl Esterases

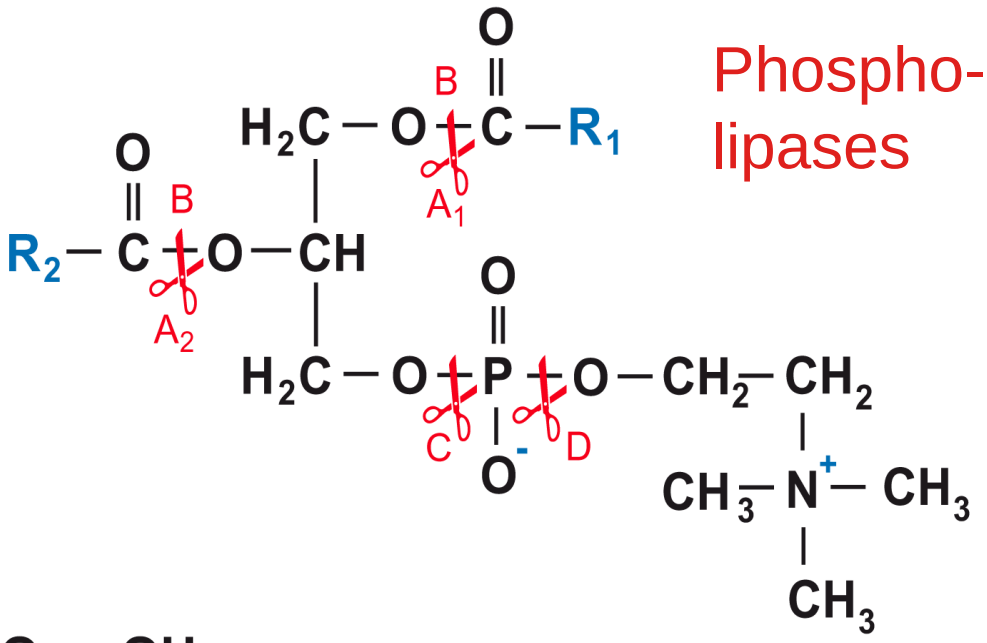
Esterases and Their Applications in Food

Enzyme	Reaction Catalysed	Applications
Lipase (triacylglycerol lipase)	Splits fats and lipids into fatty acids and glycerol or other alcohols	Maturing of cheese; emulsifier production; interesterification of fats; baking
Phospholipase A_2	Hydrolyses phospholipids (lecithin)	Improvement of emulsifying power (e.g. egg yolk); degumming
Phospholipase A_1		
Lyso-phospholipase		
Galactolipase	Splits fatty acids off galactolipids	Improvement of emulsifying power; baking
Acetyl esterase	Splits off acetyl groups, e.g. from pectin or xylan	Baking; fruit juice
Pectin esterase	Splits methyl groups off pectin	Clarification of fruit juice; gel formation; stabilizing of fruit
Exo- and endonucleases	Splits nucleic acid between phosphate and nucleobase	Flavour; yeast extract
Feruloyl esterase	Splits off ferulic acid, e.g. from wheat xylans	Flavouring; baking
Coumaroyl esterase	Splits off cumaric acid, e.g. from wheat xylans	Flavouring; baking
Phytase	Removes phosphoric acid from phytate	Digestibility & bioavailability

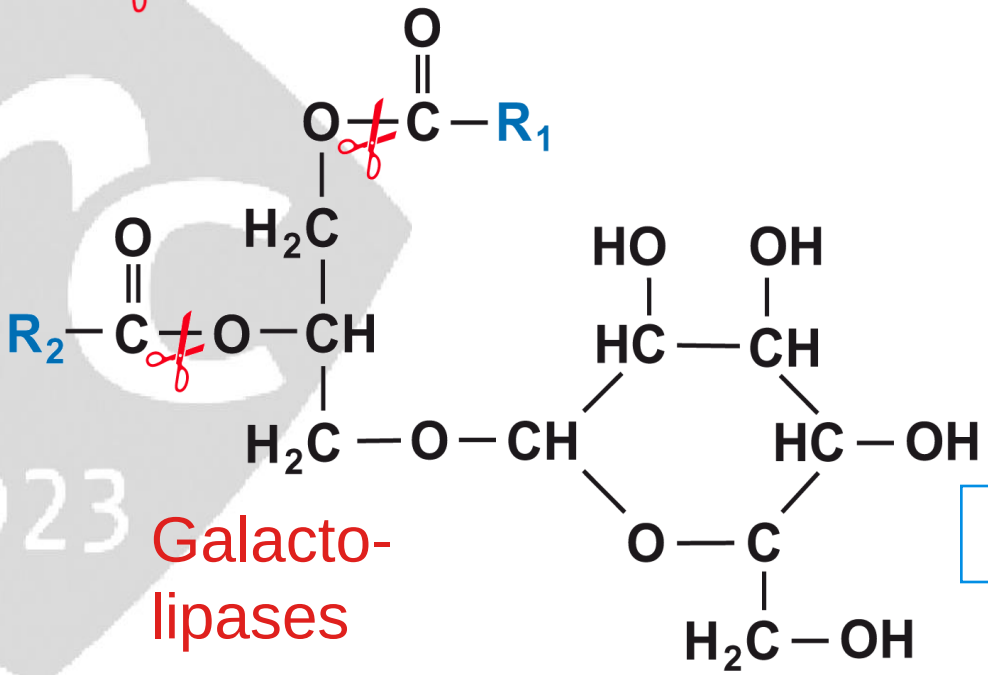
Action of Lipolytic Carboxyl Esterases



Lipases



Phospho-lipases



Galacto-lipases

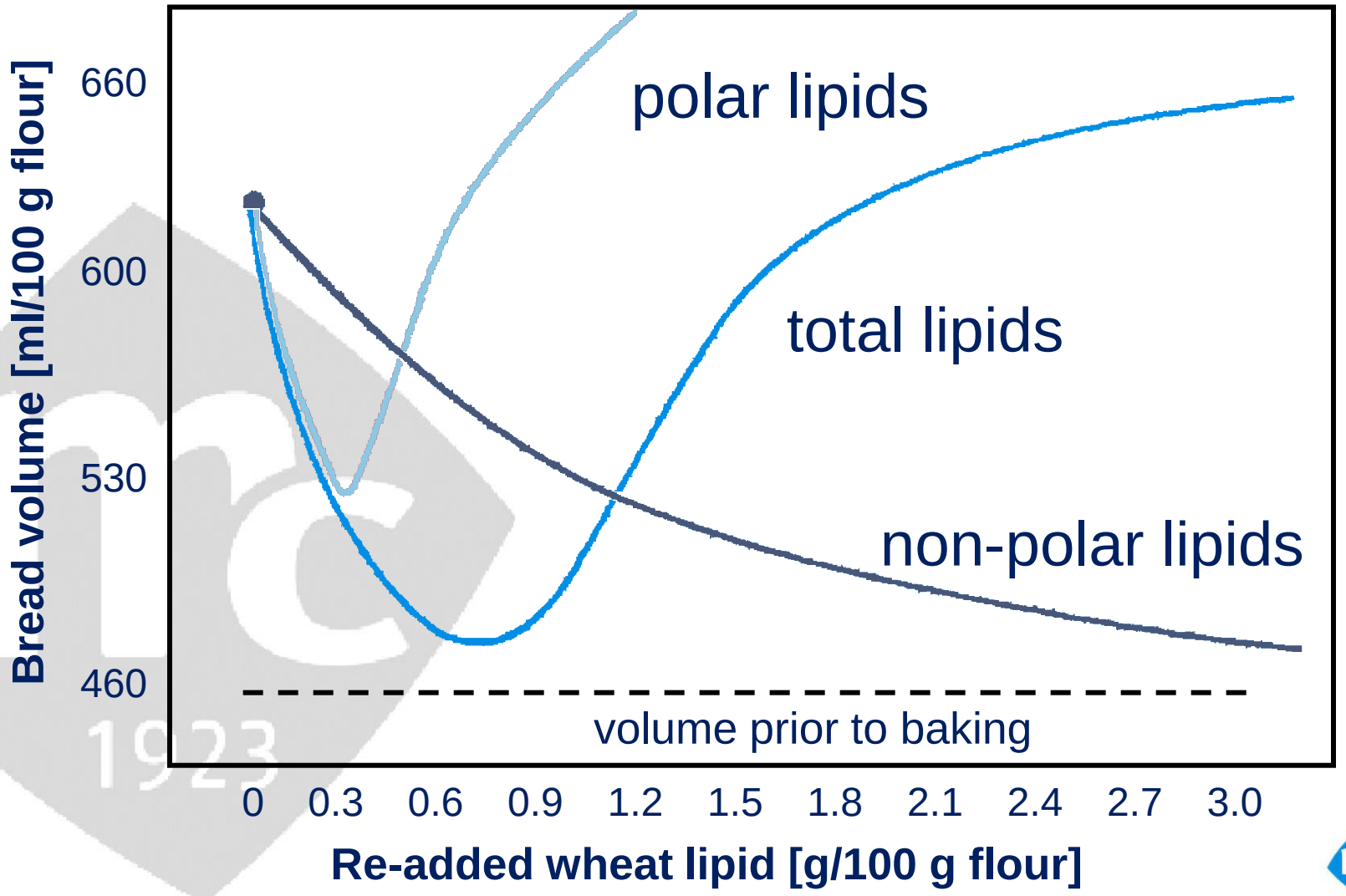
R_1, R_2, R_3 = fatty acid residues

Lipids in Wheat Flour

Total lipids*			**1,280**
Non-polar lipids			**457**
Polar lipids			**823**
Phosphatides (lecithin)		**250**	
Phosphatidyl acid	**30**		
Phosphatidyl glycerol	**51**		
Phosphatidyl cholin	**27**		
Phosphatidyl ethanolamine	**traces**		
Phosphatidyl serine	**15**		
Lyso-phosphatidyl cholin	**117**		
Lyso-phosphatidyl ethanolamine	**10**		
Galactolipids		**249**	
Other polar lipids		**320**	

***mg/100 g wheat flour 0.405 % ash**

Effect of Wheat Lipids on Volume Yield of Defatted Wheat Flour



Modif. from MacRitchie & Gras, 1973

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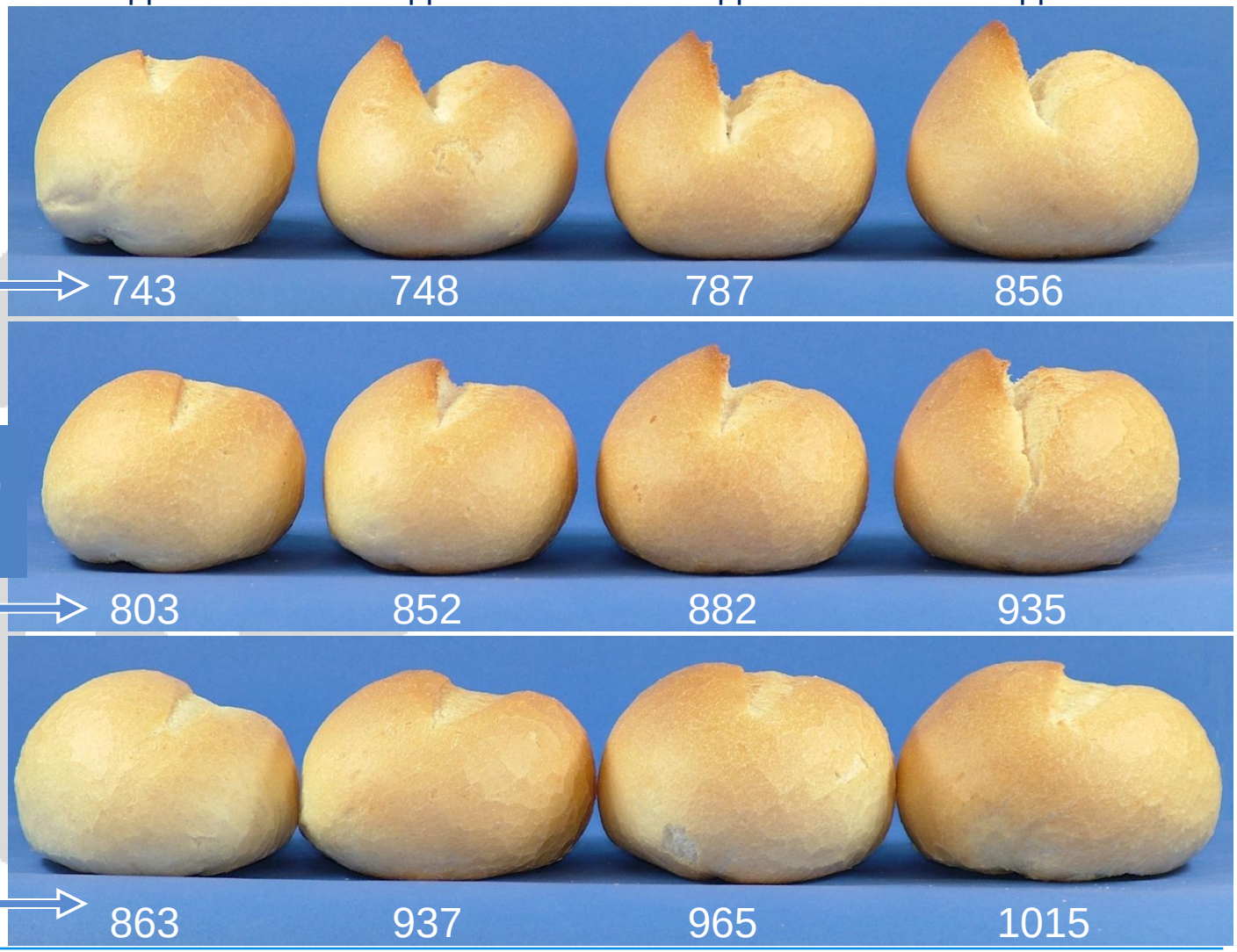
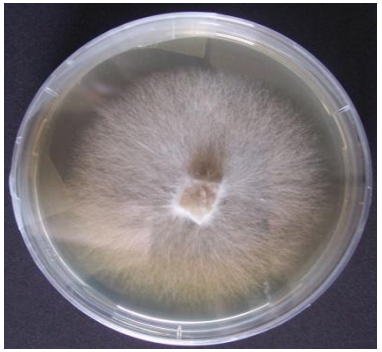
Effect of Dosage and Proof Time on Baguette Rolls with Alphamalt EFX Super

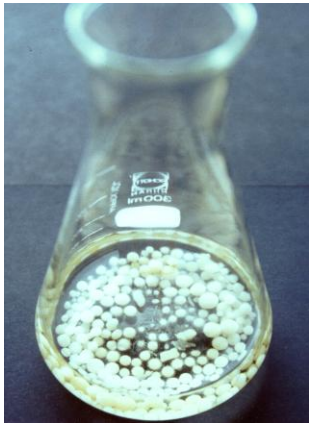


Volume yield, mL/100 g flour

Outlook: Enzymatic Bleaching

Basidiomycetes – *in vitro* Cultivation





R. Berger, 2009

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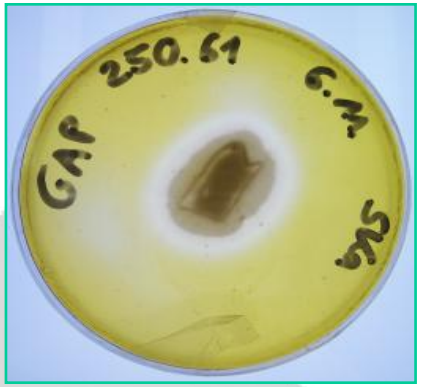
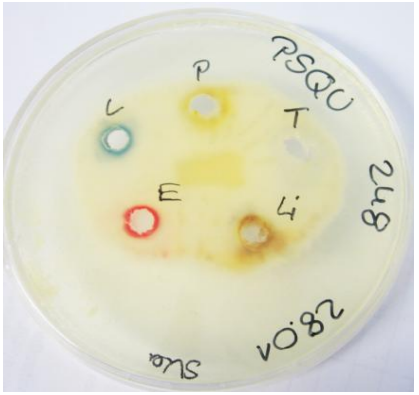
Degradation of Carotenoids – Screening for Suitable *Basidiomycetes*



screening for *β*-carotene bleachening



screening for enzyme activity

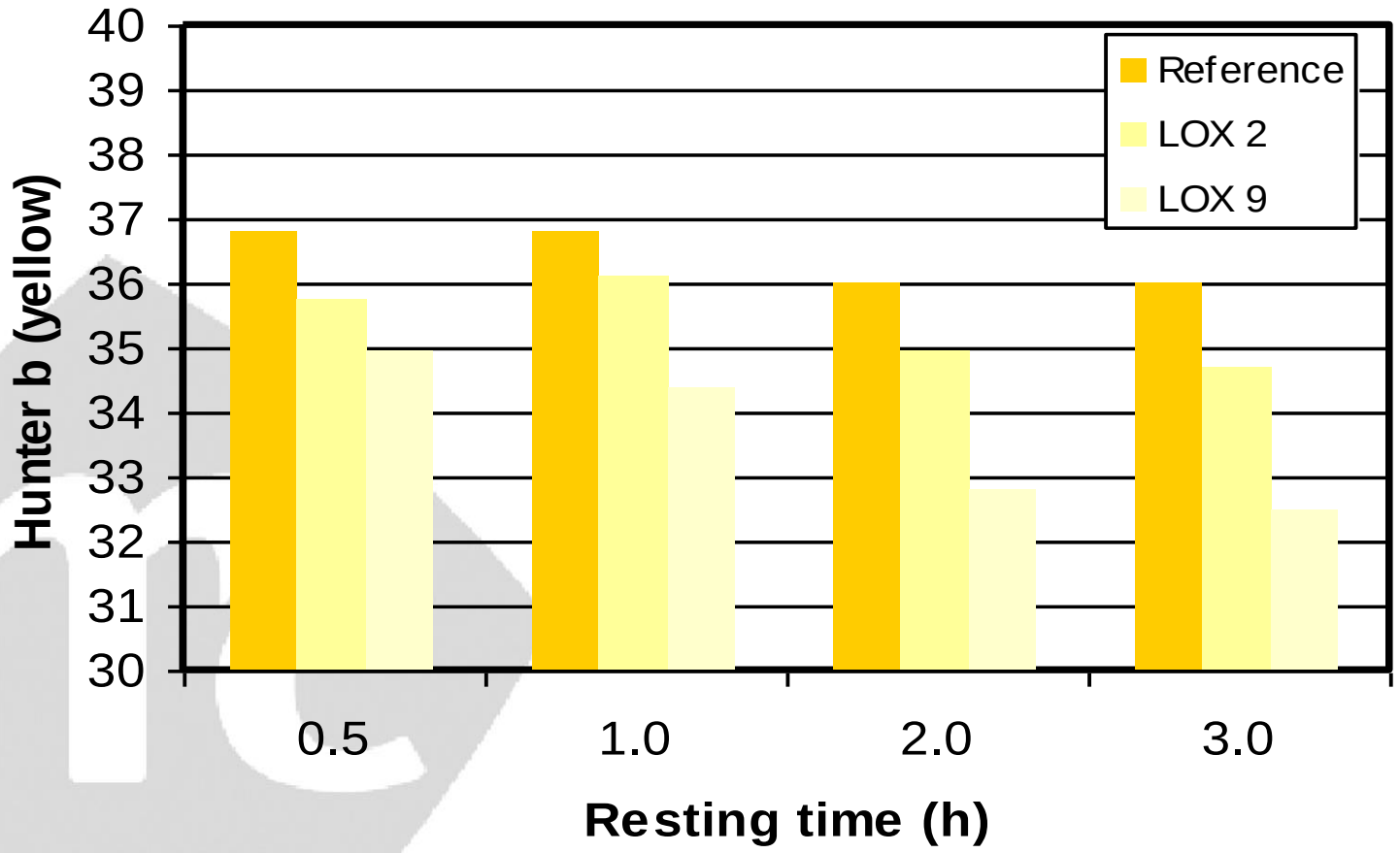
SNL agar plate with *β*-Carotene emulsion

Detection

Laccase:	ABTS
Peroxidase:	Pyrogallol / H_2O_2
Tyrosinase:	*p*-Cresole
Lipase:	*α*-Naphthyl decanoate
Esterase:	*α*-Naphthyl acetate

R. Berger, 2009

Lipoxygenase – Bleaching of Lutein in Dough



300 g flour, 196 mL water, 4 g Lutein

LOX 2 = 5 u/mL → 3.0 u/kg

LOX 9 = 2 u/mL → 1.2 u/kg

Thank You for Your Attention!

IAOM Expo, booth no. 42
www.muehlenchemie.de