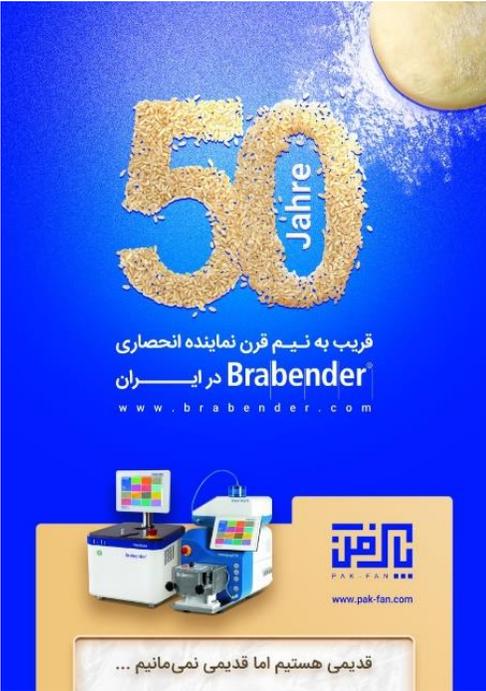


Strong And long-term Partnership



Brabender®
... where quality is measured.



IranGrain Conference
2nd Annual Grain Conference
May 10 & 11, 2022
Tehran, Iran



Glutopeak Technology to Determining Quality of Flour & Gluten



Brabender®

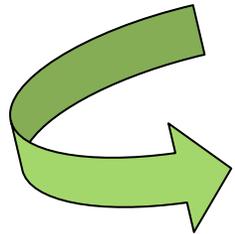
... where quality is measured.

Wheat Quality: Description and Effect

- Different wheats/flours for different products
- Same protein content but different products/applications



▪ Composition ↔ functionality



- Composition: list of components
- Functionality: the quality of being suited to serve a purpose well; practicality

“Functional properties of food proteins are those physical and chemical properties which affect the behaviour of proteins in food systems during processing, storage, preparation, and consumption”

(Kinsella, 1976) *Crit Rev Food Sci Nutr*, 1976, 7, 219-280.



GLIADIN
extensibility
viscosity

+

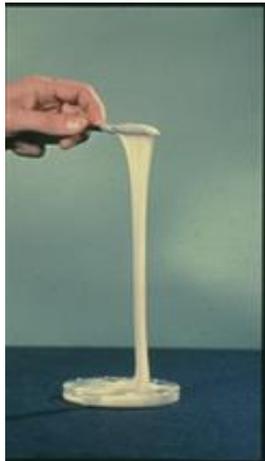


GLUTENIN
elasticity
tenacity

=



GLUTEN
visco-elasticity



**Excess of
Gliadins**
Too tensile, weak
dough

+



**Excess of
Glutenins**
Too stiff, strong
dough

=



EXTENSIBILITY

The gluten network deforms instead of breaks

ELASTICITY

The gluten network enables the product to keep its shape during mechanical stresses

It is able to resume its normal shape after being stretched

Composition

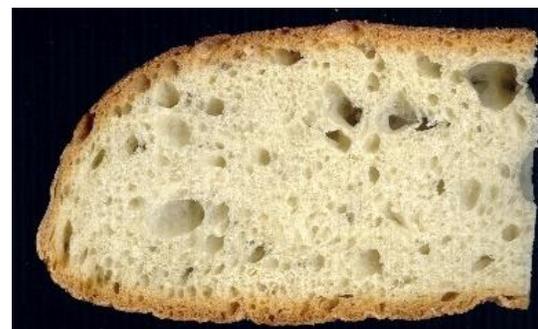
Durum
Wheat
Semolina

	[%]
Protein	10 - 16
Fiber	4 - 6
Ash	0.90 - 1.7
Starch	75 - 78

Common
Wheat Flour

	[%]
Protein	9 - 15
Fiber	4 - 6
Ash	0.55 - 1.7
Starch	78 - 80

Bread



Pasta



Pagani, unpublished



Pagani, unpublished



Who cares about wheat quality?

Breeders
Farmers

Milling industry

Baking and
pasta industry



Each sector/industry wants to use the optimal raw materials (grain – flour) for its needs, or produce end products (bread, pasta) with consistently high quality.



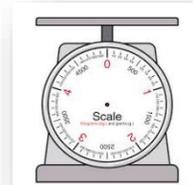
❖ Information at the beginning of the value chain

❖ Optimal collection and evaluation of the delivered raw materials

❖ Prediction of the expected baking and processing properties



- Rheological “fingerprint” of the flour
- Time, sample size, reliability and predictability





PROCESSING

Test	Time*	Sample amount	Influence of the analyst
Farinograph	~45 min**	50g, 300g	low
Alveograph	~40 min	250g	high
Extensograph	~150 min**	300g	medium
Rheofermentometer	~200 min	300g	low
Gluten Index	~15 min	10g	high
Glutograph	~20 min	10g	high
Kieffer Test	~60 min**	10g	high
Mixolab	~60 min**	50g	low

* including sample preparation and cleaning

** including the step for the determination of the optimal water absorption

The GlutoPeak Procedure

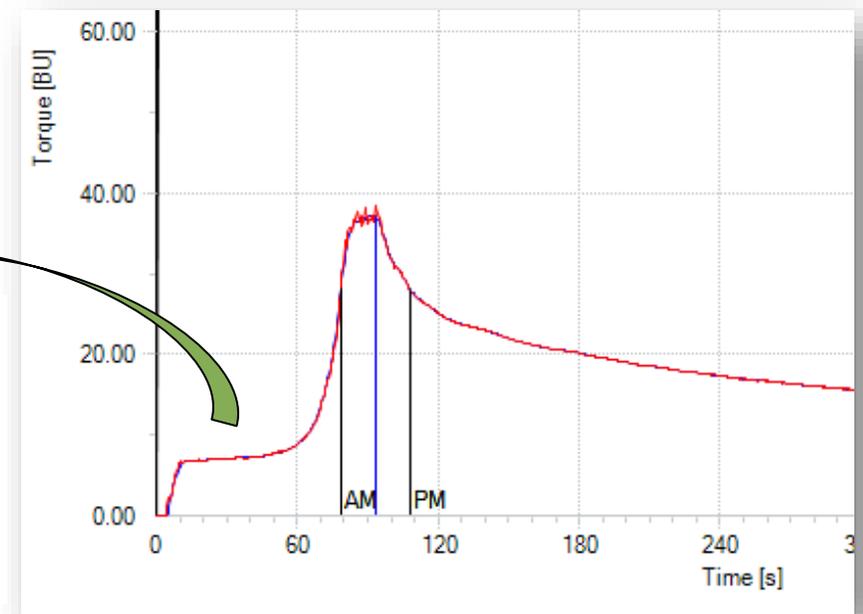
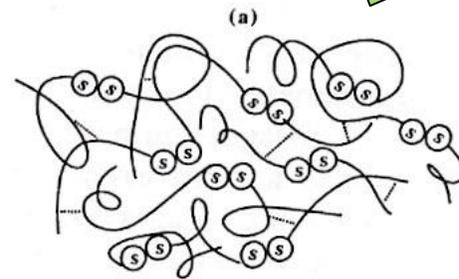
Features of the GlutoPeak and the process

- Useful for flour, whole meal flour, baking mixes, vital gluten and more
- Supplementary to the Brabender 3-Phase-System
- Creates a rheological „fingerprint“ of the test material
- Paddle speed up to 3300 min⁻¹
- Quick method (30 s – 10 min.)
- Small sample amount (2,5-12 g)
- No sample preparation necessary
- Raw material-dependent methods and evaluations available
- Simple handling



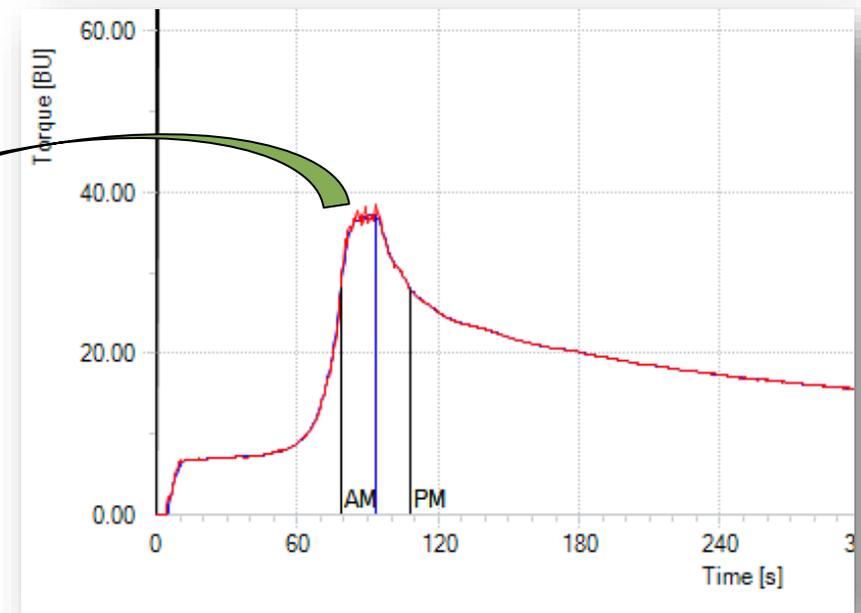
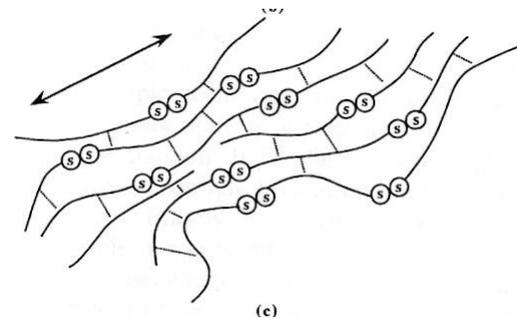
Effect on the Gluten Network

- Preparing of a slurry with flour and water during low speed
- Increased energy input due to increase in speed



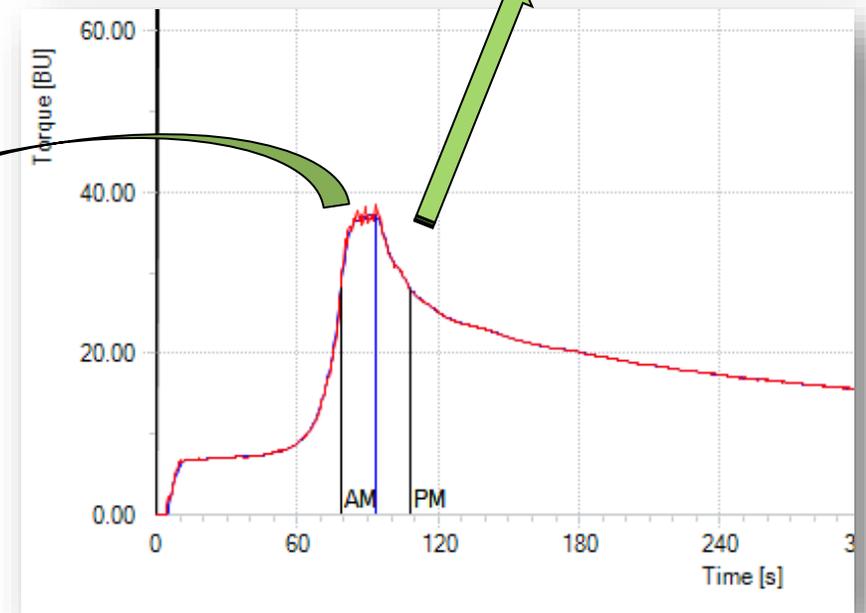
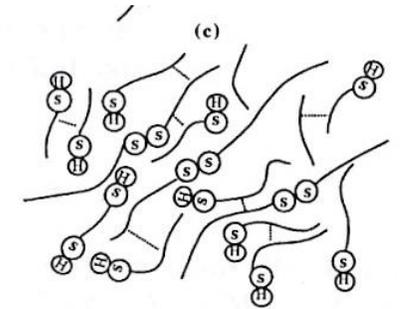
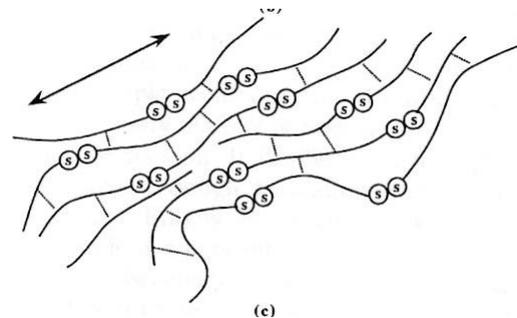
Effect on the Gluten Network

- Preparing of a slurry with flour and water during low speed
- Increased energy input due to increase in speed
- 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



Effect on the Gluten Network

- Preparing of a slurry with flour and water during low speed
- Increased energy input due to increase in speed
- 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



Description of the Evaluation

Peak Maximum Time (PMT) [s]

- Time until the gluten aggregates and the highest torque, before the gluten get damaged
- Correlate with the Gliadin content ($R = 0,70$) *)

Peak Maximum Torque (BEM) [BU]

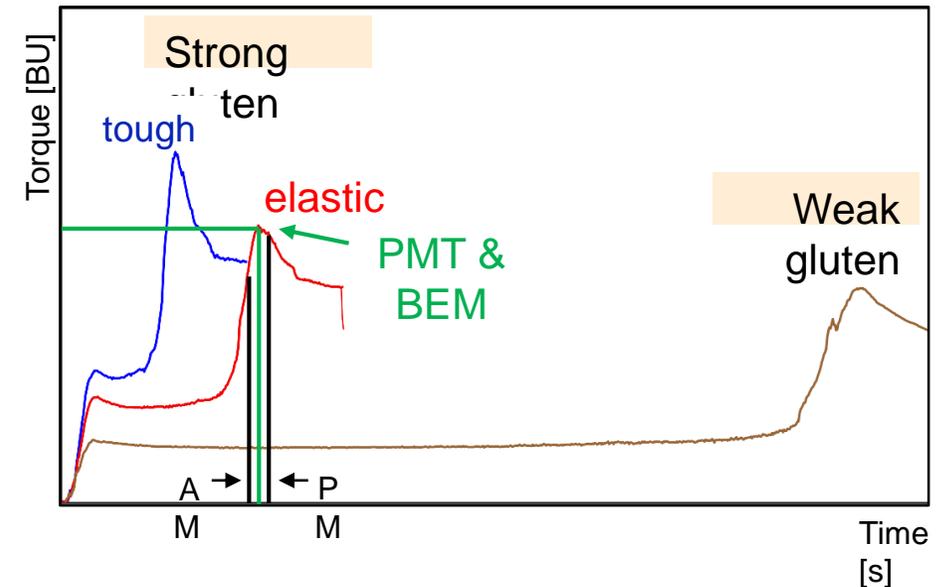
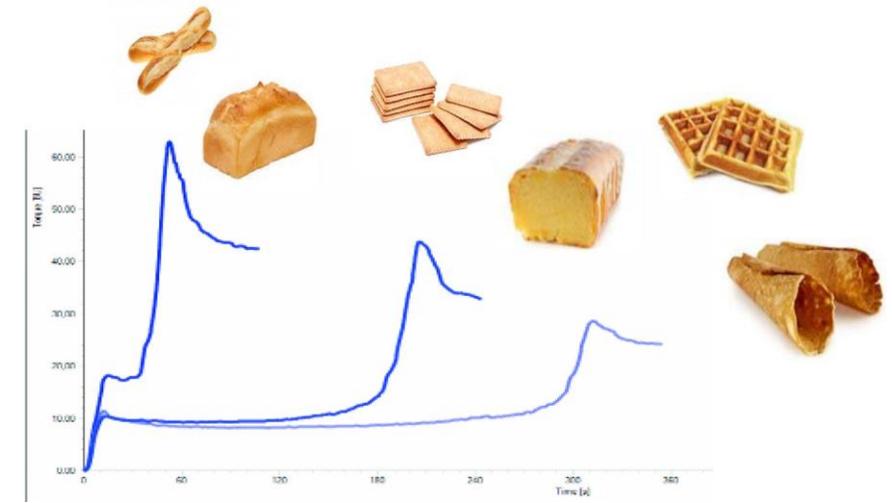
- Torque when the peak happened
- Correlate with the Glutenin content ($R = 0,72$) *)

Torque [BU]

- 15 s before Maximum (AM)
- 15 s after Maximum (PM)

Energy (cm²)

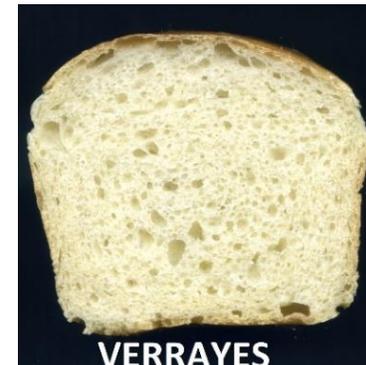
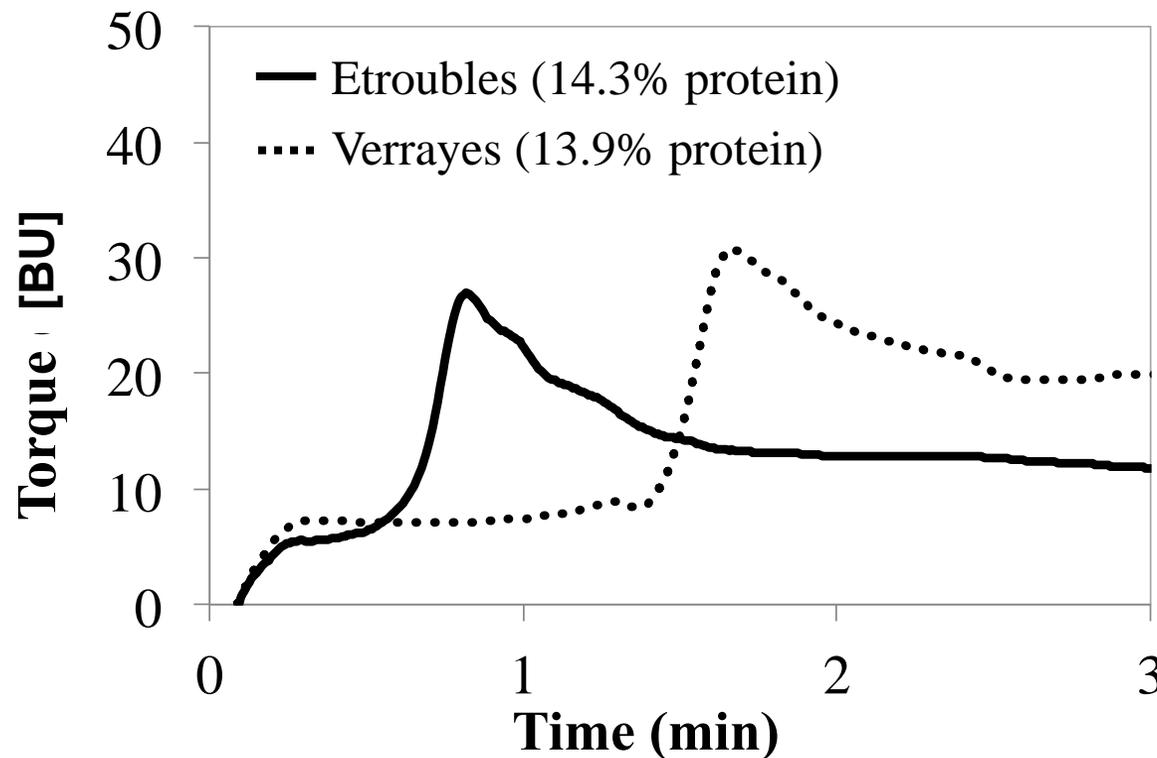
- Area under the curve
- Correlate with the Glutenin content ($R = 0,77$) *)



*) Marti et al. J Cereal Science 66. 89-95

GlutoPeak versus Protein Content

Similar protein content but different bread-making performance



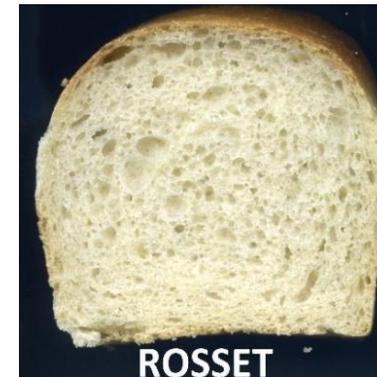
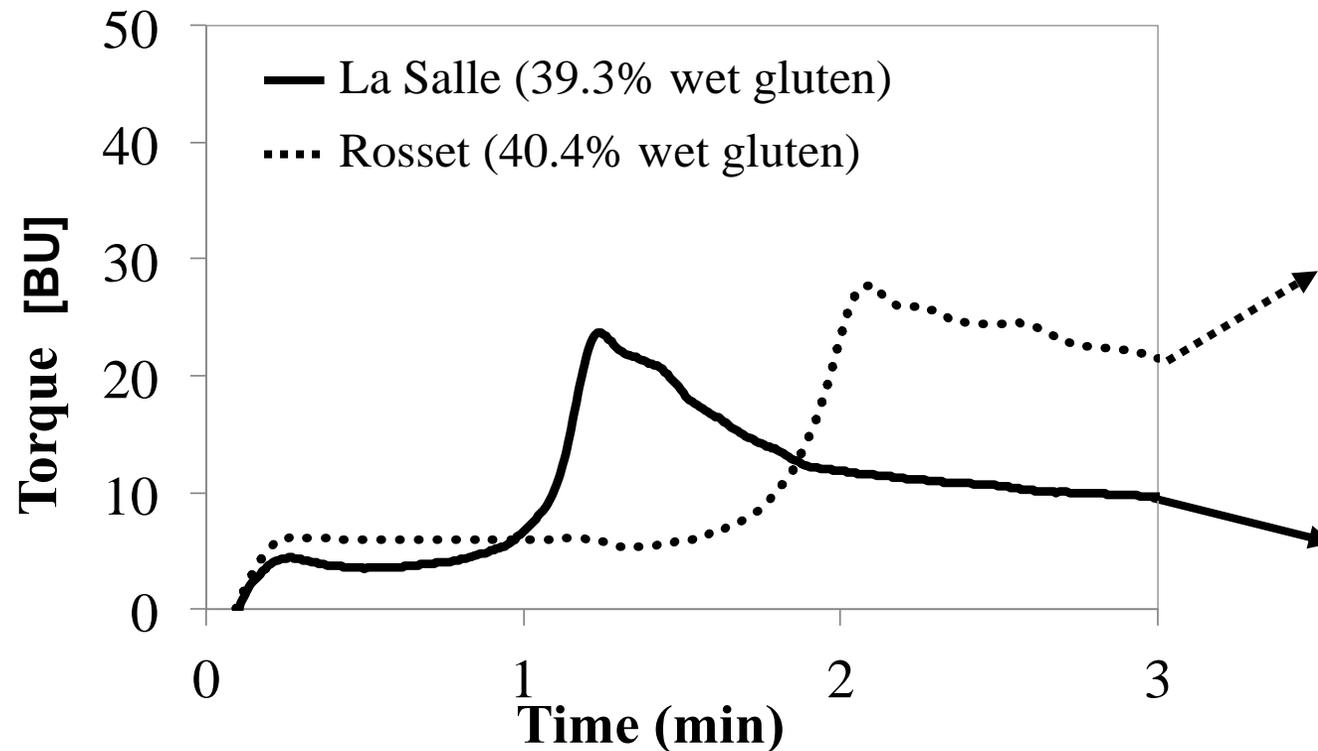
- Elastic gluten
- Good volume increase due to gas expansion in the fermentation and baking process
- Soft crumb



- Tough gluten (rigid)
- The fermentation gases could not expand through the strong gluten
- Limited volume increase

GlutoPeak versus Wet Gluten Content

Similar wet gluten content but different bread-making performance



- Elastic gluten
- Good volume increase due to gas expansion in the fermentation and baking process
- Soft crumb



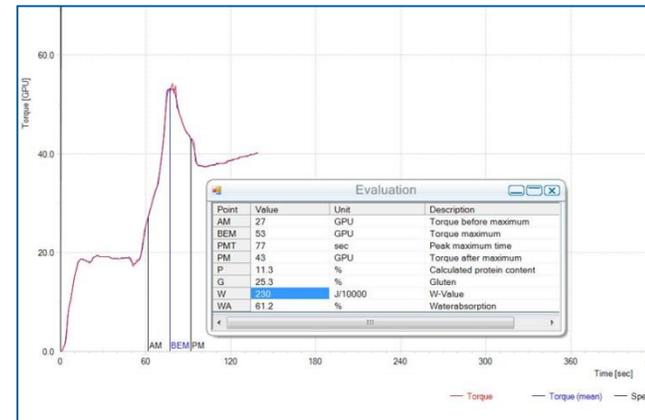
- Tough gluten (rigid)
- The fermentation gases could not expand through the strong gluten
- Limited volume increase

GlutoPeak Methods & Applications

Method: Rapid Flour Check

Wheat flour with approx. 11 – 15 % protein

Method	
Flour	9 g
Liquid (dist. water)	9 g
Temperature	36 °C
Speed	2750 min ⁻¹
Time (max. approx.)	300 s



Correlation

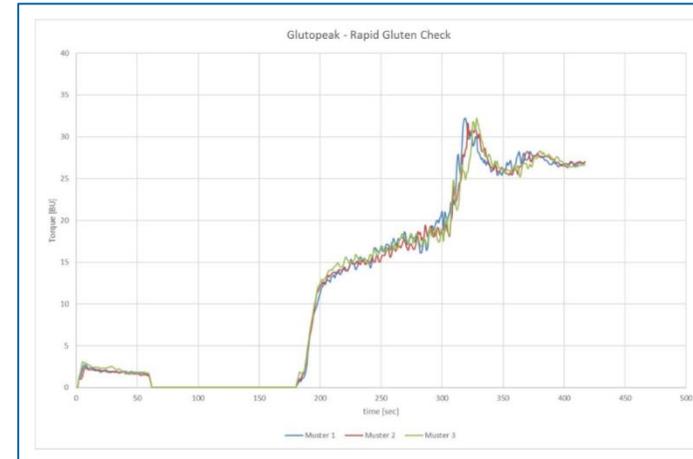
- Water absorption
- Protein content
- Wet gluten content
- W-value (Alveograph)



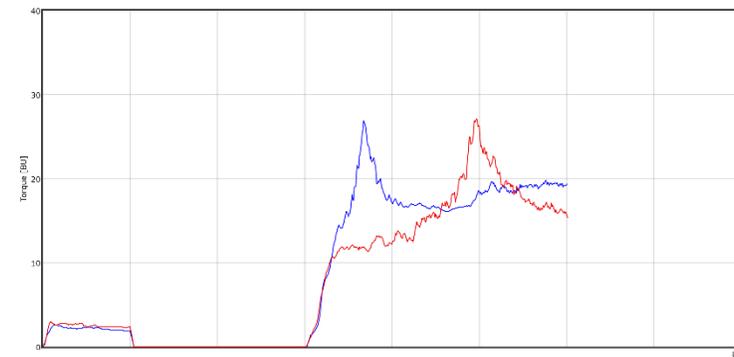
→ Quick raw material analysis with wheat flour/grain

Method: Rapid Gluten Check

Method	
Vital Gluten	2,1 g
Liquid (dist. water)	4,4 g
Temperature	36 °C
Speed	500 min ⁻¹ (1 min) 0 min ⁻¹ (2 min) 3.300 min ⁻¹ (7 min)
Time	< 10 min



Gluten with similar rheological behaviours



Gluten with different rheological behaviours



(ttz Bremerhaven)

Technical Note:





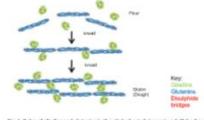
Technical Note:
Development of a method to analyse vital wheat gluten with the GlutoPeak

Sergiy Gall¹, Alexander Hentsch¹, Julian Hues¹, Jessica Wietz¹, Leslie Zeller¹
¹ Bremerhaven, S. et al., 2018

GlutoPeak – new "Rapid Gluten Check" method

Vital wheat gluten is used as a powdered additive in bakery products to improve their quality, especially in order to achieve a consistent quality in the bake or to compensate for quality fluctuations in the flour.

The properties of vital wheat gluten are significantly determined by its components, gliutenin and gliadin. Whilst gliutenin create more elastic properties, the gliadin are responsible for the plastic properties (Schäfer and Köhler, 2016). The distribution of the gliutenins in relation to the molecular weight and the intermolecular disulphide bonds are an important criterion for determining dough and baking properties and the gluten quality (Cortese and Stone, 2017). For this reason it has been very difficult and time-consuming until now to precisely determine the quality of the gluten. The following illustration shows the roles of both gliutenins and gliadins in the gluten network.



Challenges when analysing vital wheat gluten quality

The quality of powdered vital wheat gluten depends in turn on various factors. On the one hand, it is dependent on the quality of the wheat from which it is produced. On the other hand, it is also dependent on various process parameters, for instance the separation process of starch and gluten and the drying parameters, particularly time and temperature. However, the exact dependencies have not yet been fully explained.

Vital wheat gluten processors notice that different batches often differ in terms of their quality. So far no standardized methods have been established to measure the quality of vital wheat gluten in dried form and to distinguish the product qualities of different batches. Baking trials give a good impression about quality, yet are very time-consuming to carry out. This poses a major challenge for the manufacturers and processors of vital wheat gluten as they have to be able to assess quality fluctuations and even them out.

(Gall, S. et. al., 2018)

→ Quick quality control of dried (vital) gluten and its properties for the baking process

Method: Whole Meal Flour (U.S.)

Method

Whole meal flour	8,0 g
Liquid (CaCl ₂ Solution, Concentration: 55,49 g/l)	10,0 g
Temperature	20 °C
Speed	3.000 min ⁻¹

(Wang et. al., 2018)

Effects of particle size:

- The particle size has a significant influence on the results
- The methods has a higher accuracy if the particle size is smaller



GlutoPeak method improvement for gluten aggregation measurement of whole wheat flour

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ARTICLE INFO

Keywords:

Whole wheat flour
GlutoPeak
Flour particle size
Gluten aggregation
Dough rheology

ABSTRACT

A dough based device, the GlutoPeak, was developed to measure the aggregation behavior of gluten. In this study, the GlutoPeak testing protocol was improved and applied for the gluten aggregation evaluation of whole wheat flour (WFF) of different particle size ranges. The sample/baker weight ratio, mixing speed, and mixing temperature were adjusted to different levels for obtaining more repeatable Peak Maximum Torque (PMT) and Maximum Torque (MT) using two commercial WFF samples. The temperature had a greater effect on the repeatability of the PMT, while the sample/baker weight ratio and mixing speed had lesser impact on the repeatability of the PMT. The gluten aggregation of the WFF was measured using the improved GlutoPeak parameters, which were 8 g WFF and 10 g 0.5 mol/L CaCl₂ solution with a mixing speed of 3000 rpm and test temperature of 20 °C. The PMT significantly decreased with the exception of 10 g WFF significantly increased with a decrease of WFF particle size. Compared to the MixLab and Farinograph tests, the GlutoPeak method took less time and provided significantly different ($p < 0.05$) results for WFFs of different particle size ranges.

1. Introduction

Whole wheat flour (WFF) is milled from the whole grain kernel that contains bran, germ, and endosperm. It is considered a highly nutritious and inexpensive source of protein, carbohydrates, dietary fiber, and various minerals. Considerable scientific research has confirmed the positive effects of WFF products intake on human health (Chen, 2007; Charter & Liu, 2010). United States Department of Agriculture (USDA) recommends that Americans should consume at least half of their grains as whole grains (USDA, 2013), and outline the whole grain-rich criteria for national school meals (USDA, 2013). Along with the increasing health awareness of consumers and recommendations of scientists, a large market demand for various WFF-based products is expected in the near future (USDA, 2013; Jung, Seo, Ho, & Lee, 2013). One of the major challenges of WFF application is the influence of wheat bran, which results in changes in dough rheological properties, and further affects the quality of food products (Choi, Choi, Hyun, Jung, & Park, 2016; Cho, Kim, Lee, & Cho, 2016; Singh, Bhatnagar, Mishra, Toppand, & Langrish, 2015; Wang, Sun, Brown, & Lee, 2013). Many studies have been conducted to reduce the influence of bran in

products by adding vital wheat gluten, enzymes, and adjusting the particle size of bran fractions (Sakic-Biosackic, Pantic, Vranic, Vranic, & Anin, 2006; Frenkel, Collin, & Hosen, 2009). Compared to other methods, obtaining the particle size of bran is more natural and cost effective.

Several rheological instruments, such as the Mixograph, MixLab and Farinograph, have been developed and applied to dough systems (Chang et al., 2010; Rabot, Kabanem, Sassi, Chery, & Duber, 2009; Mounier & Scherren, 2002; Viallis & Sorelli, 2013). However, it is difficult for these instruments to detect meaningful differences in dough rheological properties for WFFs of different bran particle size ranges. Previous studies reported no significant effects of bran particle size regarding water absorption in the Farinograph (Choi, Lee, Hwang, Haney, Seok, & Hwang, 2010; Chang & Shown, 1997), and dough development time in Mixograph (Choi et al., 2010) and MixLab (Choi, Han, Lee, Mounier, & Duber, 2010) of WFFs.

Recently, a new technique has been investigated as a more efficient and rapid predictor of wheat flour rheological quality (Clausen & Sorellsen, 2012; Mouri, Cochran, O'Gallagher, Dickinson, & Pagnier, 2014; Moly, D'Amico, Sorelli, Hosen, & Sorellsen, 2013).

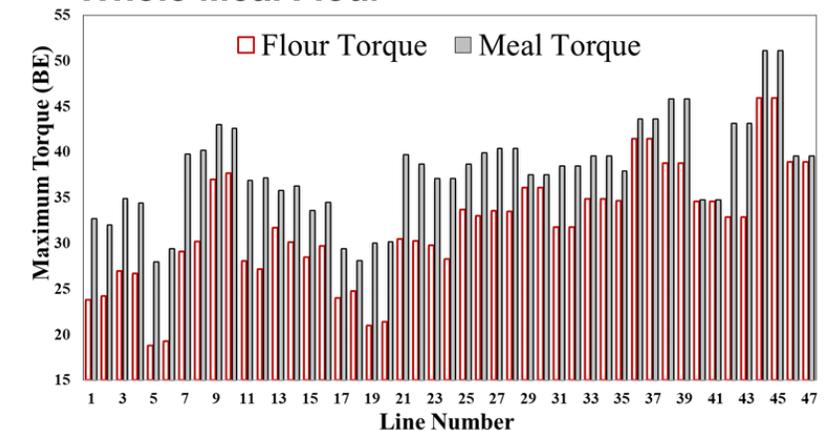
Corresponding author: Wheat Marketing Center, Inc., 1300 NW Niles Parkway, Suite 100, Portland, OR 97209, USA.
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0023-6460/© 2017 Elsevier Ltd. All rights reserved.

(Wang et. al., 2018)



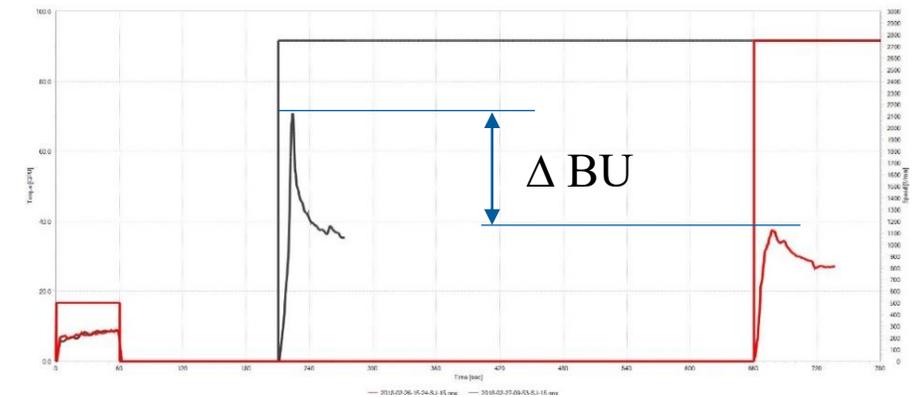
Peak Maximum Torque of White Flour and Whole Meal Flour



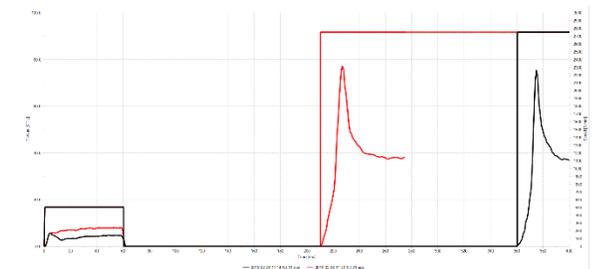
Dr. Sanaa Ragaei – University of Guelph, Canada

Method: Suni-bug Damage

Suni-bug Method		
	1. Test	2. Test
Whole meal flour	9g	9g
Dist. Water	10g	10g
Temperature	40 °C	40 °C
Speed	500 min ⁻¹ (60 s)	500 min ⁻¹ (60 s)
	0 min⁻¹ (150 s)	0 min⁻¹ (600 s)
	2.750 min ⁻¹ (150 s*)	2.750 min ⁻¹ (150 s*)
* Stop latest 15s after the peak		



High tendency for suni-bug damage



Low/no tendency for suni-bug damage

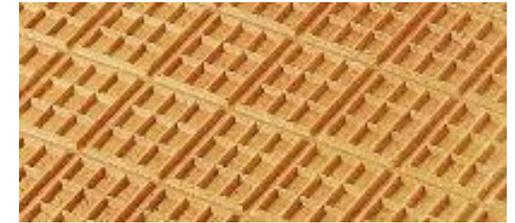
→ High reduction of the peak maximum → Tendency for suni-bug damage

Method for Wafer Flour (Low Protein Flour)

Project Haas-Bühler AG Austria & Brabender Germany

Challenges in Wafer Production

- Gluten (also in flours with low protein content) can lead to blockages in the dosing nozzles
- Deviations in flour quality lead to non-optimally filled wafer moulds
- Conventional flour analyses (ICC) take up a relatively large amount of time



Task of the Project

- Optimization of the flour analysis
- Development of a fast method with good correlations to common measurement methods

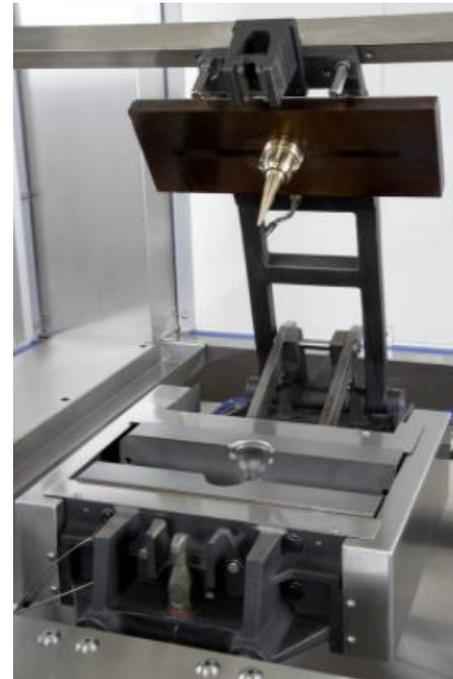


Description of the Baking Trials

Laboratory baking pan and a corresponding core plate (Wafer cone baking oven)

- Mould heating temperature : 180 °C
- Core heating temperature: 190 °C
- Sample size: 7 ml
- After closing the oven:
 - 2 s open
 - 2 s close
 - 2 s open
 - 2 s close
- Baking time: 80 s
- Cooling down 10 min. at room temperature
- Foil sealed storage at 8 °C

„Breath“



Texture Analysis of the Waffles

Measurements were done with a TA.XT.plus Texture Analyze (Stable Micro Systems)

- Measurement of the force necessary to produce a fracture
- Force transducer: spherical
- Pressing the ball into the wafer opening
- Recorded texture parameters
 - Distance travelled by the ball
 - Force required to break the wafer
- 10 wafer cones were tested per flour



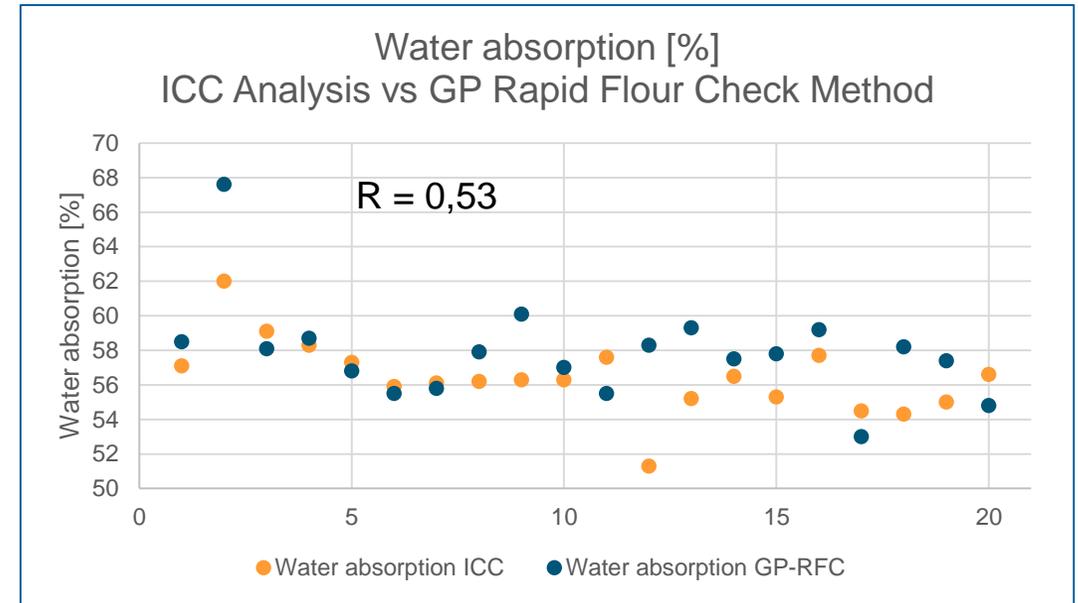
Results and Discussion

Project Haas-Bühler AG Austria & Brabender Germany

Evaluation with the GlutoPeak RFC Method

No optimal correlations to the reference analysis (ICC)

- Protein R = 0,85
- Wet gluten R = 0,75
- Developed for wheat flours with approx. 11 – 15 % protein
- Protein content of the project flours: 9,0 – 11,4 (15) %



➔ Optimisation of the existing method ➔

Korrelationen

- Water absorption
- Protein content
- Wet gluten content



Method	RFC	LPC ^{*)}
Flour	9 g	11 g
Liquid (dist. water)	9 g	12 g
Temperature	36 °C	35 °C
Speed	2750 min ⁻¹	2500 min ⁻¹
Time (max., approx.)	300 s	300 s

^{*)} Low Protein Check

Project Participants

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Mrs. Zuleyka Rodríguez (Application Technology Wafer)

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FHW Franz Haas Waffelmaschinen GmbH, Leobendorf, Austria

(Planning, carrying out and evaluating the experiments in the Haas-Bühler technical centre)

Mr. Markus Löns



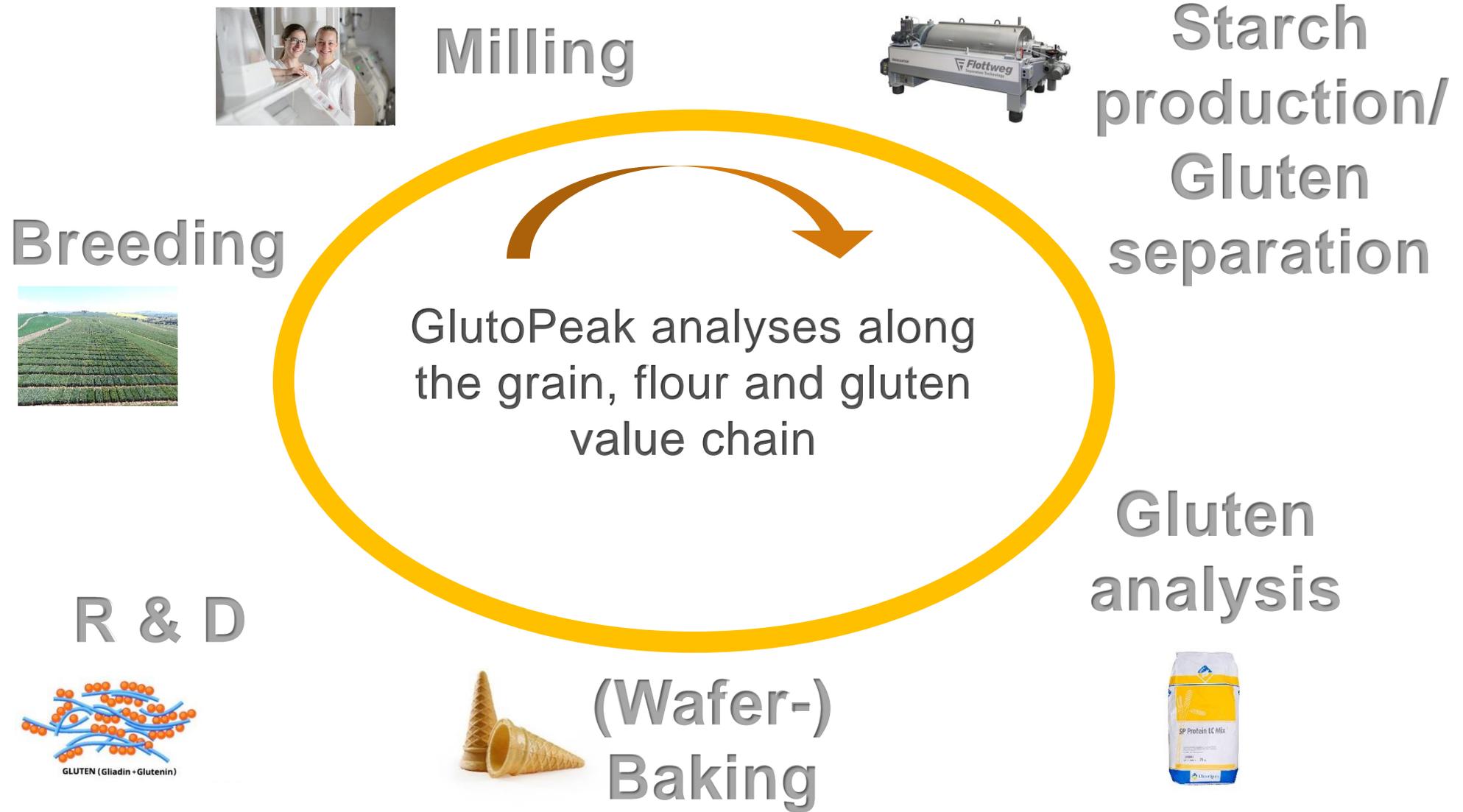
markus.loens@brabender.com

Brabender GmbH & Co. KG, Duisburg, Deutschland

(GlutoPeak and laboratory technology)

"... a valuable alternative to the ICC methods..."

*"... the flexibility of the GlutoPeak with its low sample volume and short test time proves to be a suitable alternative for the characterisation of wafer flours."
(Bühler, 2020)*



- Alessandra Marti (PhD)
- M. Ambrogina Pagani (PhD)
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