Flour Quality Assessment

Wheat flour constitutes over 50% of bread formulas and about 25% of cake formulas. So controlling the quality of this key ingredient is essential. It's quality related to breadmaking performance is usually determined by:

- Protein content: Protein quantity in the wheat kernel is mainly dependent on cultivar, soil type, soil nutrients and crop climate conditions.
- Composition of gluten-forming proteins (glutenins-to-gliadins ratio): Upon hydration, gliadins behave as a very extensible material, almost a viscous liquid, while glutenins as a cohesive solid. Although both influence gluten behavior, it is the larger polymeric glutenins that wield the greater influence on gluten quality.
- Molecular size distribution of glutenins: High-molecular-weight (HMW) glutenin subunits have a major role in dough rheology and gluten strength.
- Amount and location of cysteine residues of gluten-forming proteins that contain thiol groups, i.e. oxidation potential to form disulphide bonds which create gluten-starch matrices strong enough to retain CO2 during breadmaking.

What to Look for in Flour

When selecting flour for a given application, it is important to bear in mind that flour must be compatible with the intended processes and formulations, and comply with the required quality attributes for optimum end product results.

Quality attributes of flour directly related to food safety (i.e. contamination indicators):

- Microbiological parameters
- Mycotoxins and aflatoxins content
- Heavy metals content
- Pesticide residues

Quality attributes directly related to processability of flour:

Physicochemical	Rheological properties of flour/water dough (resistance to deformation)
1. Moisture content 2. Protein content 3. Gluten content (wet and dry) 4. Ash content 5. Falling number (FN) 6. Particle size distribution 7. pH 8. Hardness or softness of grain kernel (e.g. particle size index, PSI) 9. Solvent retention capacity (SRC)	1. Mixolab 2. Alveograph 3. Extensograph 4. Farinograph 5. Viscoamylograph 6. Rapid Visco Analyser (RVA)

Bread Flour

Bread flour intended for industrial baking is obtained from the following wheat classes:

- Hard red winter (US)
- Hard red spring (US)
- Hard white (US)
- Canadian western red spring (CWRS)
- Canadian prairie spring red (CPSR)

Rheological properties of industrial bread flour

Rheological parameters of flour/water doughs are based on the viscoelastic nature of dough. The viscoelasticity of dough is thanks to its unique composition of gluten-forming proteins and the polymeric matrix they create. Rheological assessment tools, such as the Mixolab and the Alveograph allow millers and bakers to evaluate the strength of wheat gluten when dough is subjected to stress forces which cause deformation.

Bread flours are characterized by being able to tolerate greater deformation forces and retaining polymeric network integrity while absorbing large amounts of water during a given test. This is mainly due to their:

- Larger glutenin/gliadin ratio (quality factor)
- Higher protein content (quantitative factor)
- Higher cysteine residues that bind together separate glutenin molecules into larger protein aggregates (quality factor)

Adjusting for flour composition

Flours with protein deficiencies and/or poor rheological performance which exhibit high tendency to gas bubble coalescence during proofing or baking, can be supplemented with the following ingredients and improvers:

- Vital wheat gluten
- Oxidizing agents, e.g. ascorbic acid or acerola cherry extract
- Oxidizing enzymes, e.g. glucose oxidase, hexose oxidase
- Third generation lipases highly specific phospholipase and/or galactolipase
- Polar emulsifiers, e.g. deoiled lecithin, DATEM and SSL

Mixolab Parameters of Bread Flour

Parameter	Value (indicative)	Interpretation	Indicator
Absorption (consistency of 1.1 ± 0.07 Nm on the C1 torque)	62.0 – 65.0%	The stronger the flour, the higher the absorption	Gluten quality and damaged starch content
Stability Time around C1 where the torque is higher or equal to the real value of C1 – C1*11%	8.0 – 10.0 min	The stronger the flour, the higher the mixing stability	
C2 (N x m)	0.5	The higher the value, the higher the tolerance to fermentation	
C3 (N x m)	1.6	The higher the value, the lower the starch damage	Gluten quality and damaged starch content
C4 (N x m)	1.45	The lower the value, the higher the enzymatic activity	
C5 (N x m)	2	The lower the flour, the more tender the crumb and the longer the shelf life	

Alveograph Parameters of Bread Flour

(Example, different processes might require different flours):

Parameter	Value
P (tenacity)	90 – 125
L (extensibility)	130 – 150
P/L	0.7 – 0.85
W	320 – 380

Cake Flour

Cake flour intended for the production of batter layer cakes, angel food cakes and sponge cakes is made from the following wheat classes:

- Soft red winter (SRW) (US)
- Soft white (SW) (US)

Given its lower flour level compared to the other ingredients in a cake formula and it's lower protein quantity, flour quality and its rheological behaviors are not as pertinent. However, any enzymatic activity should not be considered detrimental.

High-quality cakes rely on proper formula balance. A solid knowledge on chemistry and function of sugars, fats, eggs, gums, starches and baking powders, is therefore critical to optimum end product results.

Technical specifications for cake flour

Component	Value
Moisture	13.00%
Protein content (N x 5.7)	5.0 – 7.0%
Ash	0.23 – 0.35%
Dry gluten	3.5 – 5.0%
Falling Number	450 – 600
Particle size index, PSI	30.0 – 35.0%
pH (chlorinated)	4.5 – 5.0

Mixolab Parameters of Cake Flour

Parameter	Value (indicative)
Absorption (consistency of 1.1 ± 0.07 Nm on the C1 torque)	50.0 – 52.0%
Stability Time around C1 where the torque is higher or equal to the real value of C1 – C1*11%	3.0 – 4.0 min
C2 (N x m)	0.23
C3 (N x m)	2.5
C4 (N x m)	2.45
C5 (N x m)	3.5

HOW TO TEST FLOUR QUALITY

Flour quality assessment requires the following components:

- A laboratory, in-house or external, with enough analysis capacity (equipment, reagents and trained technicians)
- Continuous support from suppliers for proper equipment calibration (especially for dough testing equipment such as Mixolab, alveograph, etc.)
- Documentation of spec sheets and technical requirements. Flour cannot be evaluated without a standard or target quality parameters

In cake flour, protein content is 5–7%. How is flour protein and the protein from ingredients different?

Proteins are made from amino acids, which are the building blocks of any food system. They are highly functional in how a product acts during processing. How a protein functions depends on where it comes from. Therefore, functionality is largely not dependent on quantity of the protein, but on its type. Egg and whey protein provide foaming and emulsification for colloidal stability and structure setting. These particular proteins function differently from gluten proteins. Gluten proteins in batter applications, functions in viscosity and network building, but lacks the foaming and emulsification ability. High gluten protein levels would result in a tough cake. While high egg or whey protein levels would result in more foaming, and therefore, a softer cake.

Can I simply replace all-purpose flour with bread flour + cake flour, and adjust the formulation?

Yes, you can. Blending flours from soft and hard wheats is a common practice in countries. Usage of gums and emulsifiers are usually the most common adjustment to produce the same product volume and crumb tenderness. This should be a short term alternative. In the long run, this replacement will not be cost effective because bread and cake flour are specialized flour that sell at a premium.

Which mixing property of the farinograph is the most important?

Most industrial bakers look at the absorption and MTI as important Farinograph values. It is generally accepted that stability and absorption correlate to a greater degree with Alveograph values (W and P/L) than MTI or development time. The Farinograph should not be used as the sole source of rheological information though it is a valuable tool in wheat breeding. Modern equipment which uses a more sensitive and precise torque sensor, such as the Mixolab, have been developed to provide additional information on flour's baking performance.

My flour is very, very weak. Which enzyme should I use?

It is highly recommended to establish how "weak" the flour really is by using the Mixolab and/or Alveograph. This way you can have a better idea of the flour you are using and how much enzyme and/or improvers you will have to add to your bread formula to compensate for the lower quality flour. You can use glucose oxidase as a start, using the Mixolab to determine how well it functions. If glucose oxidase doesn't provide what you are looking for, look at an oxidant like ascorbic acid. A combination of both glucose oxidase and ascorbic acid would help give your flour a boost.

I'm adding vital wheat gluten to supplement my white flour. In a farinograph test to check the effect, dough development time and stability actually decreased. What could be the reason for this?

When testing VWG in the Farinograph or Mixolab, some people use constant hydration and others may use an adapted hydration test. It is key to remember that in order to be fully functional, gluten proteins must undergo hydration and plasticization. If too much VWG is added without adjusting absorption, there will be not enough water to develop a polymeric network and excess "dry" gluten particles will behave the same way as bran particles which disrupt and weaken the gluten network.

Water Absorption, Yes! But...

Water absorption is a key property for specifying and verifying the overall quality assurance but it does not forecast properties of the dough and final product. There are three different flour components involved in water absorption (glutenins, damaged starch, and pentosans), and each of these has a distinctive physical effect on the flour.

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