# Milling Technology: Interpreting Functional Properties in Enhancing End Product Quality

Presented to:

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## Wheat Products

Bread, Laminated products, Pizza, Cookies & Crackers, Pastries & Cakes

Noodles, Steamed Breads & Dumplings

Pasta – Long goods (Spaghetti, Linguini…) Short goods (Rotini, elbows…)

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# Flour Quality – Function of Wheat Quality & Milling Process

The common and main ingredient in all the products is flour/semolina derived from wheat.
Flour/semolina quality is a function of wheat quality and the quality of the milling process applied.

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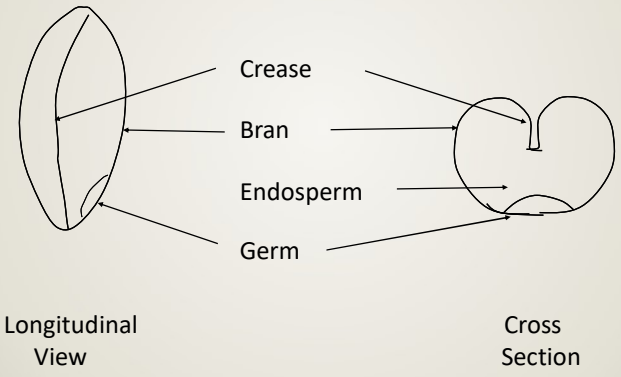
# Wheat Kernel

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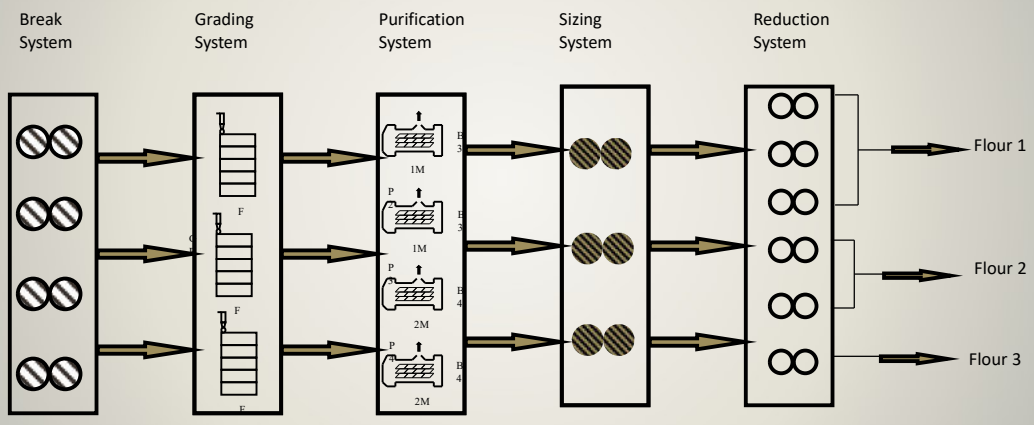
## Milling Process-Higher yield of low Ash flour

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## Flour Constituents - Functional Properties

So what are the principal constituents of wheat flour that are involved in generating the functional properties?

They are:

- Starch
- Protein
- Sugar
- Fat
- Pentosans
- Ash

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## Wheat Products – Specific Flour Quality

Each of these Wheat products is produced using specific flour quality. These qualities are well defined with a set of data

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## Defining Flour Quality

**Protein:** Flour quality is typically specified by its protein content and protein quality. These help characterize the most important functional properties of a given flour.

**Starch:** Being the largest component of the wheat flour, its quality has important bearing on the processing and the final quality of the end-product. Starch viscosities and pasting properties are important information for leavened baked products and other end-products. It is also important to have a direct measure of alpha-amylase activity to determine whether a wheat is acceptable for an end-use application.

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## Examples – Flour Functional Properties

- Gluten Content & Quality
- Alpha-amylase activity
- Ash, Colour
- Starch Damage, Particle Size Distribution

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## Implicating Factors – Flour Functional Properties

| | |
|---|---|
| Protein | Protein Content & Quality |
| Starch | Alpha-amylase activity |
| Minerals | Ash, Colour |
| Milling | Starch Damage, Particle Size Distribution |

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## Wheat Products – Flour Specifications

The secondary processors have a set of quality data specified for millers to meet. These are referred to as flour or semolina specification that are required to fulfill the quality needs.

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## Specifications and Performance

Flour may be rejected by a customer if it did not meet the required specifications even before checking its performance

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## Flour Quality Spec. & End-use Testing

The specifications are set to ensure acceptability and suitability of a flour for a given product. However, an end-product test (bake test) is still considered the gold standard to assure suitability.

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## Wheat Products – Preparation of Specific Flours

As mentioned earlier, each of these Wheat products is produced using flour of specified quality. These specific flour qualities are generated as follows:

- Wheat blends of hard, medium or soft wheat
- Wheat blends of varying protein level
- Low, medium or high extraction flours /semolina
- Appropriate incorporation of flour improvers
- Particle size distributions

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## Formulation of Wheat Blend

| Protein Content | Protein Strength | End Use Application |
|---|---|---|
| High | Strong | High-Volume Pan Bread and Buns |
| Medium | Medium | French Bread, Variety Noodles & Steam Bread |
| Low | Weak | Cakes, Pastries & Cookies |

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## Wheat Flour Protein

When a sample of wheat flour is hydrated and kneaded, it forms a dough with visco-elastic properties.
Viscosity in the dough comes from the starch fraction while elasticity comes from the protein fraction which forms gluten upon hydration. The dough such formed when carefully washed under the water until almost all the starch is washed away, a rubbery mass remains which is referred to as gluten. It is the gluten content and the quality of it, that are considered vital for all the wheat-based products.

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## Wheat Protein & Wet Gluten

There is a strong correlation between Wheat Protein and wet gluten content. Higher the protein higher will be the wet gluten content. For example, in Canadian CWRS wheat if the protein content is 12.0%, it is estimated that wet gluten content will be about 30% or more derived by multiplying with a factor of 2.5 .

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## Wheat Protein & Wet Gluten

The role of gluten is key in all wheat products. For example, in bread making the crumb structure and the cell walls are formed by gluten, generating required texture. In noodle production , proper development of the gluten network through sheeting is important for acceptable results. The balanced dough properties that is required for most products are derived from appropriate gluten properties. Miller's job is to provide flour with good gluten content and quality while it is secondary processors' function to develop the gluten network well to suit the end-products requirements

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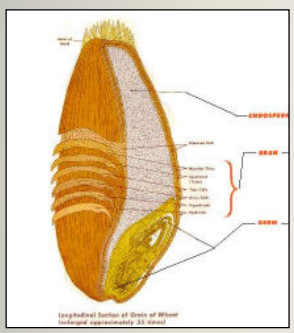
## Wheat Protein, Wet Gluten & Flour Extraction



There is a protein gradient within a kernel of wheat. Going from the center of the kernel towards the bran layers the protein increases along with its gluten content. Very close to the bran layers the gluten goes down but the protein continues to increase.

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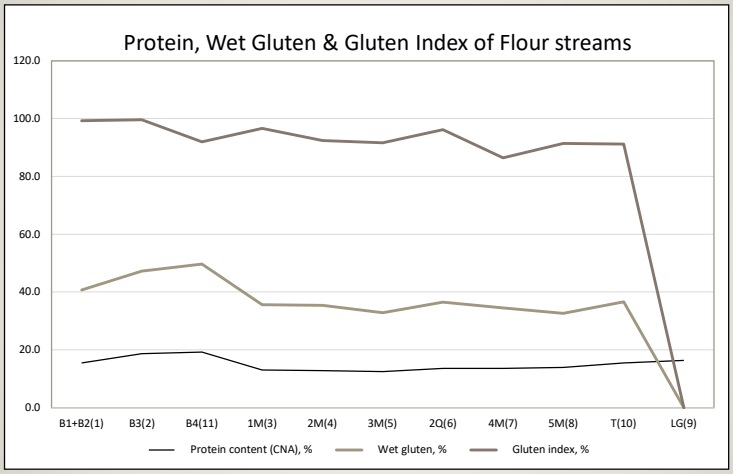
## Wheat Protein, Wet Gluten & Flour Extraction

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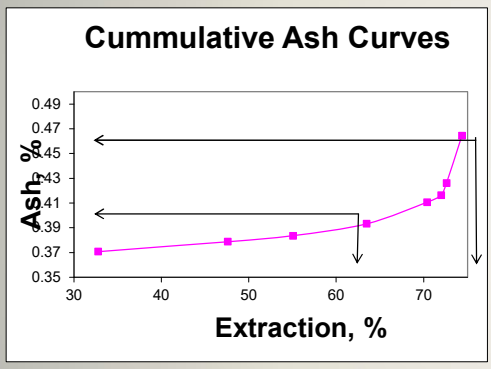
## Wheat Protein, Wet Gluten & Flour Extraction




Like protein gradient the ash also increases from the center going out to the bran layers. Between 60% and 75% Th ash curve shows noticeable increase in the ash and likewise in protein/gluten content and other quality attributes. When lower grades of wheat are used, the quality gets worse.

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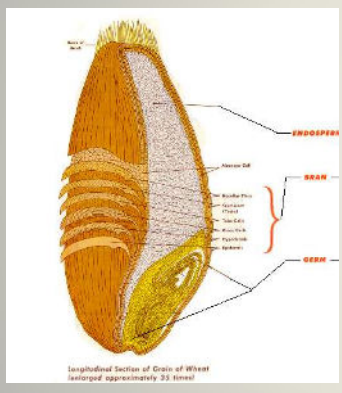
## Flour yield improvement at same ash content



Endosperm content in a wheat kernel is 83%. This means if the bran and germ can be removed cleanly, converting the entire 83% of the endosperm into flour would theoretically yield 83% of good white flour. However, in practice, the flour extraction of 75.0% at an acceptable ash content of 0.5% is usually achieved by most milling facilities and is considered good.

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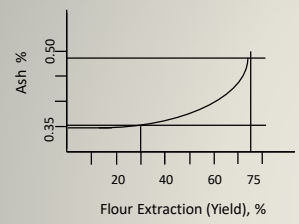
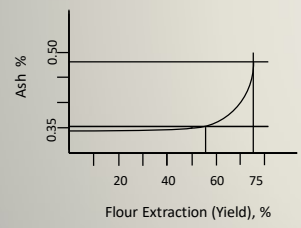
## Flour yield improvement maintaining quality




Cumulative ash curve of Simplified grading system and comprehensive grading system.

About 7%-8% of the remaining endosperm gets contaminated with bran and germ in an effort to get maximum possible flour yield of acceptable quality.
This would mean that theoretically there is still a potential for increasing the yield of flour up to a maximum of about 7%-8% (83%– 75%) from the residual, and highly contaminated low-grade material.

Source: Milling flour for Asian Products, A. Sarkar, CFW

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## Flour yield improvement maintaining quality

| | Key Points |
|---|---|
| 1. | Good Wheat , Test weight, kernel weight |
| 2. | Tempering |
| 3. | Good break releases from early passages, good corrugations |
| 4. | Produce highest proportion of flour from early head reductions |
| 5. | Minimal residual flour |

The partial recovery of a portion of such residual flour is a function of proper wheat quality, tempering , mill adjustments, equipment conditions, such as, corrugation and reduction rolls' conditions. Smallest gain here of acceptable quality is going to make a difference on a company's earnings

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## Flour yield improvement – Good Wheat Quality

Lower Grade

Higher Grade

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## Flour yield improvement maintaining quality

| | Lower Grade | Higher Grade |
|---|---|---|
| WHEAT (13.5% mb) | | |
| Test weight, kg/hL | 76.3 | 84.2 |
| Weight per 1000 kernels, g | 23.6 | 38.8 |
| MILLING YIELD | | |
| Flour yield (total products basis), % | 73.2 | 75.8 |
| Flour yield (0.50% ash basis), % | 71.7 | 76.8 |
| FLOUR (14.0% mb) | | |
| Ash, % | 0.53 | 0.48 |
| Colour - L* | 83.7 | 85.1 |

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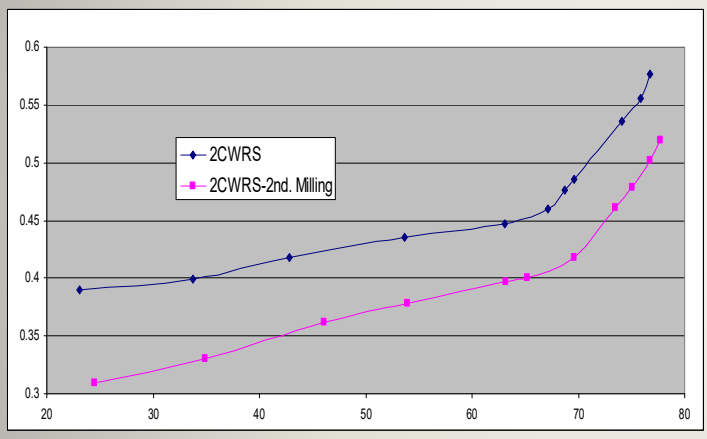
# Flour yield improvement – Optimized Tempering




Often tempering process is not working at its optimum level. This is particularly true when wheat of different degree of hardness are blended together for tempering. Optimized tempering process can reduce the percentage of residual flour ensuring clean separation of bran and germ from the endosperm.

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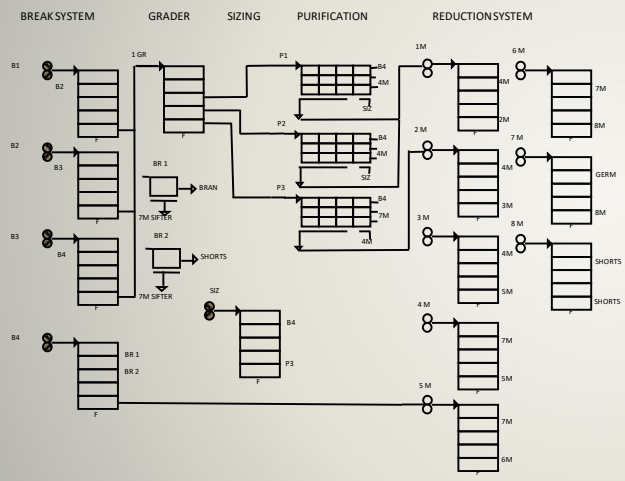
# Flour yield improvement – minimal residual flour




It is logical to look for streams that feed the low grade. How the stream with relatively better quality can be minimized before it ends up in the low-grade passage. Generally, material coming from preceding reduction passage is better in quality over the material trickling over from low end break passages and/or bran dusters.

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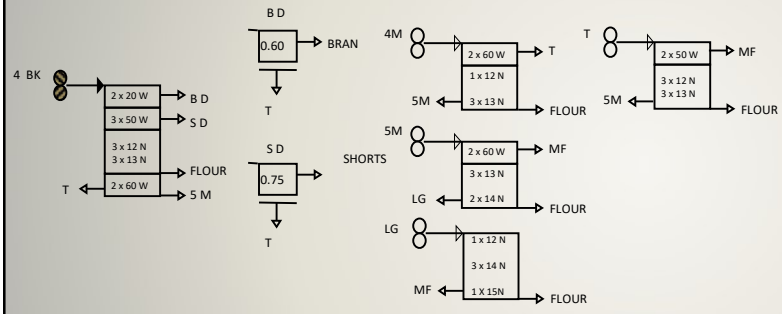
# Flour yield improvement – Minimizing residual flour




As can be seen from the attached diagram, if we investigate streams that feed 5M passage it is easily observed that the stream from 4m when reduced, potentially minimizes loss of good quality material from being passed on to 5M and onwards.

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# Flour yield improvement – Miniming residual flour

Streams coming from different passages are similar in quality with minimal differences. This is how flowsheet is designed.

- Quantity
- Quality
- Particle size

As the output of a plant is reduced compromises become essential with respect to similar qualities to meet the requirements of quantity as you need sufficient quantity to feed a passage with adequate material.

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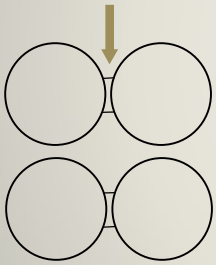
## Flour yield improvement – Fine Flour particle size

Eight Rollermill



At the same time, it is noteworthy to put an effort to produce fine flour particle size from quality standpoint. The indirect benefit of this will be reduction in good quality material from moving down the stream to the lower end of the mill.
Therefore, fine grinding on the head-end reduction passages would make sense here too.

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## Flour Protein

- Protein content
- Protein quality

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## Flour Protein Content

Protein content is measured by:

- NIR
- CNA

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## Protein content Measurements

Flour Protein

- CNA measurement of Protein content

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## Protein content Measurements

CNA measurement of Protein content

- Benefits of CNA measurement
- Transition from Kjeldahl to CNA showed higher protein due to more efficient measurement of nitrogen by CNA

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## Flour Protein Quality

Protein quality is assessed by:

- Gluten index
- Dough Rheology

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## Protein Quality Measurement

- Gluten Index

Dough Rheology
- Farinograph
- Extensograph
- Alveograph

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## Dough Rheology

The assessment of rheological properties of the dough is critical to processing, and final product quality. Flour produced from a high protein wheat with strong gluten will form a dough that will be different in its development and behaviour than that of flour produced from a medium protein and medium gluten strength.

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## Dough Rheology

Likewise, when a flour is produced from a low protein and weak gluten strength the dough properties are very weak. Farinograph measures water absorption required for mixing and development of a dough at a fixed dough consistency . It essentially measures resistance to mixing while collecting information on changes in rheological properties .

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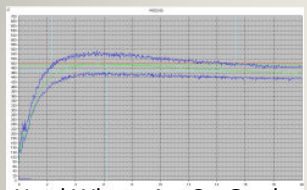
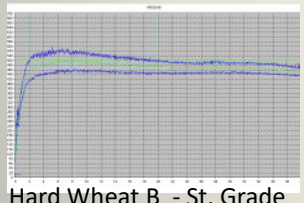
## Dough Rheology



Hard Wheat A - St. Grade



Hard Wheat B - St. Grade

The attached farinograms are showing two strong curves. Careful observation reveals Hard wheat B to be stronger than Hard Wheat A. Sometimes the data is insufficient to provide a clear picture, but a close look shows a faint sign of double peak.

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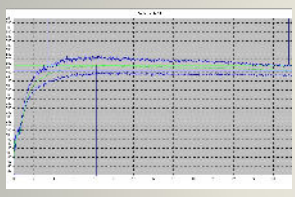
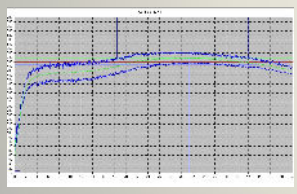
## Dough Rheology



Hard Wheat A - Patent



Hard Wheat B -Patent

As we evaluate the darinograms of the patent flours from the same wheat, we observe Hard Wheat B exhibiting a very strong curve that does not quite look like it is developed.

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## Farinograph - Influence of Milling

| | Sample - Hard Red Spring | | | |
|---|---|---|---|---|
| **FARINOGRAM** | 76.6% | 40% | 60% | 72% |
| Absorption, % | 67.9 | 66.2 | 66.6 | 67.4 |
| Development Time, min | 9.5 | 36.5 | 10.5 | 8.3 |
| Mixing Tolerance, B.U. | 25 | 10 | 5 | 20 |
| Stability, min | 19.5 | 48.7 | 50.1 | 20.2 |

Typically , low ash, white patent flour exhibits strong gluten properties and is also associated with lower water absorption. As the flour extraction increases the water absorption increases and gluten strength gradually goes down, e.g., whole grain vs. Straight grade flour.

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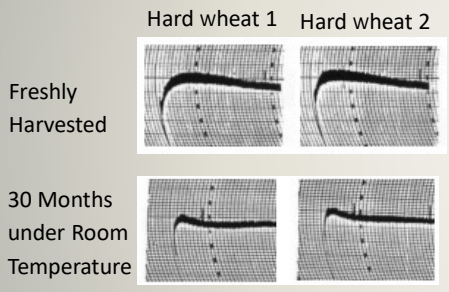
## Farinograph - Influence of Storage Time




The gluten properties in wheat changes over a long period of storage. The magnitude of change depends also on the ambient temperature. The assessment of rheological properties of the dough under such conditions will exhibit that of a wheat with very strong gluten properties.

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## Farinograph - Data Interpretation

| | | | |
|---|---|---|---|
| Stability, min | 10.7 | 8.2 | 9.4 |

Often most millers and end users use stability as a bench-mark for gluten strength. Longer stability values means higher gluten strength.

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## Farinograph - Data Interpretation

| | | | |
|---|---|---|---|
| MTI, BU | 31 | 44 | 19 |
| Stability, min | 10.7 | 8.2 | 9.4 |

Lower values of Mixing Tolerance Index is indicative of strong gluten property demonstrating good tolerance to over mixing.

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## Farinograph - Data Interpretation

| | | | |
|---|---|---|---|
| Development time, min | 6.5 | 6.2 | 5.5 |
| MTI, BU | 31 | 44 | 19 |
| Stability, min | 10.7 | 8.2 | 9.4 |

Longer it takes a dough to develop, stronger is the dough . Looking at all the data in the three columns it appears that the data shown in the 1st column seems to be the strongest.

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## Farinograph - Data Interpretation

| | | | |
|---|---|---|---|
| Absorption, % | 55.0 | 58.4 | 63.2 |
| Development time, min | 6.5 | 6.2 | 5.5 |
| MTI, BU | 31 | 44 | 19 |
| Stability, min | 10.7 | 8.2 | 9.4 |

As we now take the water absorption into account the 3rd column seems to be the strongest as it can take a higher amount of water yet maintaining good strong mixing properties.

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## Farinograph - Data Interpretation

| **FARINOGRAM** | **Medium Winter** | **Medium Spring** | **Hard Red Spring** |
|---|---|---|---|
| Absorption, % | 55.0 | 58.4 | 63.2 |
| Development time, min | 6.5 | 6.2 | 5.5 |
| MTI, BU | 31 | 44 | 19 |
| Stability, min | 10.7 | 8.2 | 9.4 |

When a dough takes a high amount of water along with good dough development time, mixing tolerance index and a long stability these combined data points to a good gluten strength.

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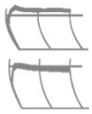
## Farinograph – Range of Gluten Strength Assessment

Very Strong



Very Weak

There is a fairly-wide spectrum of gluten strength that needs to be assessed. This requires mixing capability appropriate to the gluten strength needs.

Often very weak and very strong doughs are not accurately discriminated due to weaker dough properties or under-developed doughs showing very similar results.

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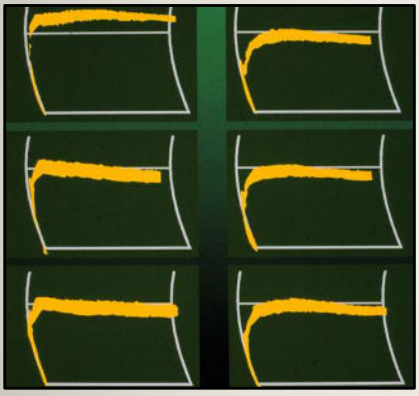
## Farinograph - Data Interpretation

Ver Strong Strong



Visual evaluation of the curves of both very strong and strong do not show much difference except the top curve under the "very strong" category. This was primarily because the farinograph blade speed was increased significantly to develop the dough.

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## Mixograph

Mixograph uses much smaller sample size. The mixing action in this machine is very intensive. This helps in developing very strong doughs allowing easier discrimination.

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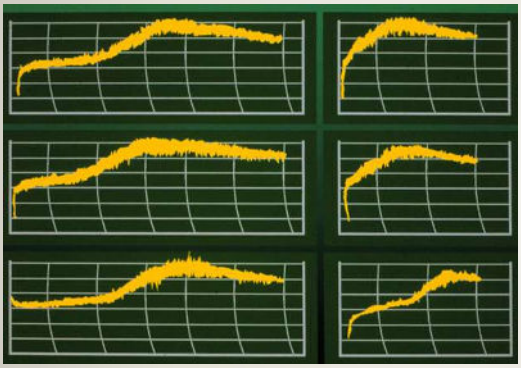
## Mixograph - Data Interpretation

Ver Strong Strong



The graphic illustration of the same farinograph curves are showing a distinct difference amongst the very strong and strong doughs as the very strong doughs are fully developed as well.

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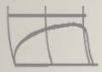
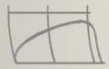
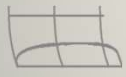
## Extensograph







The assessment of rheological properties of the dough also involves resistance to extension. Balanced dough properties is often desired for most products. It is important to evaluate the dough properties over time as in most processes the dough sits for a period of time. Most bread doughs require good gluten strength. This can be very effectively determined by extensograph.

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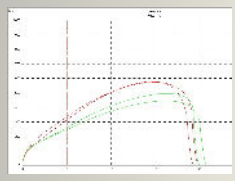
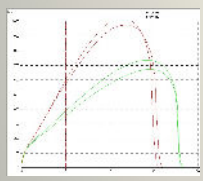
## Extensograph



Hard Wheat A - St. Grade



Hard Wheat B - St. Grade

The assessment of rheological properties of the dough is characterized as being balanced when the resistance on the Y axis is in balanced proportion to the extensibility as shown on the X axis. The two attached extensograms are showing that the bottom chart is not well balanced as the resistance appears to be higher in proportion than its extensibility.

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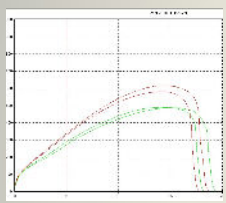
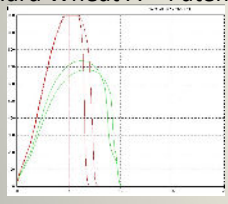
## Extensograph



Hard Wheat A - Patent



Hard Wheat B - Patent

When we observe the extensograms of the patent flours from the same wheat, the Hard Wheat B shows much higher resistance and very inextensible gluten. This gives an indication that to obtain a good processing dough this particular flour needs to be blended with other flour providing more mellow doughs. Often such flours are treated with reducing agents to make it work.

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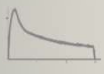
## Alveograph



The Alveograph was originally developed for the assessment of soft to medium dough properties. That is why a fixed water absorption of 50% is used for the preparation of the dough. The area covered under the curve is energy represented as “W” value. Higher “W” value points to stronger gluten strength. Height of the curve is represented by “P” value, while the extensibility is measured by “L” value. Increase in “P” value and P/L value also represents higher gluten strength.

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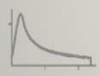
## Alveograph



In addition to the increase in P and P/L on account of increased gluten strength, these values can also increase on account of higher starch damage levels when hard wheat is evaluated. This happens because the doughs are prepared on a fixed water absorption of 50%. This issue is not relevant when milling soft and medium hard wheat where the starch damage levels are much lower

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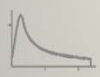
## Alveograph

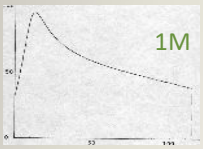


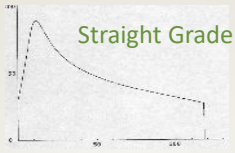
Alveograph tests are carried out on hard wheat blends in many countries. As long as the blend ratios and other processing conditions remain similar such evaluations still provide good insight.

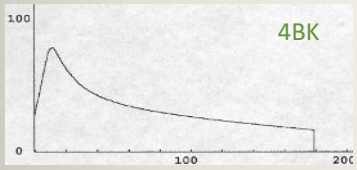
W, P and G values are linear so they can be used for blending flours to meet a desired final specifications.

58

## Alveograph Analysis: stream comparison





The Alveograph curves of various flour streams are different in appearance due to varying protein content, quality and starch damage level.

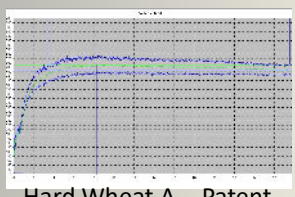
59

## Alveograph Analysis: Harf Wheat stream comparison

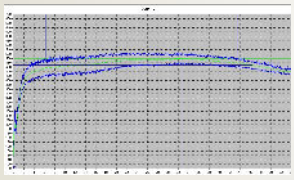
| | 1&2BK | 4BK | 1M | LG | St Gd |
|---|---|---|---|---|---|
| SD* | 14.7 | 21.5 | 18.9 | 31.3 | 22.1 |
| P | 73 | 87 | 105 | 101 | 99 |
| L | 153 | 180 | 114 | 30 | 119 |
| P/L | 0.48 | 0.48 | 0.92 | 3.43 | 0.83 |
| W | 392 | 389 | 435 | 109 | 370 |
| Ie | 68.3 | 54.8 | 67.2 | | 59.4 |
| G | 27.6 | 29.9 | 23.8 | 12.1 | 24.3 |

60

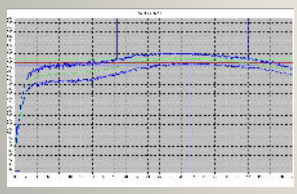
## Blending Flour - Farinograph Properties



Hard Wheat A - Patent
Stability 24.2



Hard Wheat A & B - Blend
Stability 37.3

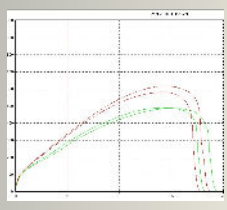


Hard Wheat B - Patent
Stability 23.7

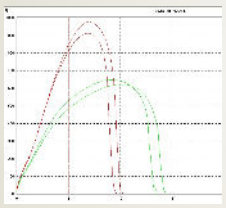
Farinograph data, such as, stability is not linear. As can be seen from the attached charts that blending a stability of 24.2 min with 23.7 min at 50/50 blend ratio, the blend shows a stability of 37.3 min. This is difficult to understand when strictly looking at the data. However, observing the charts it is not difficult to understand

61

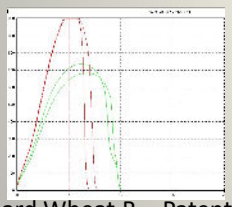
## Blending Flour – Extensograph Properties



Hard Wheat A - Patent



Hard Wheat A & B - Blend



Hard Wheat B - Patent

The Extensograph curve of the same two flours show the blend to be closer to the stronger curve of Hard Wheat B. It is difficult to predict what the blended flour would provide or look like until the actual test is performed. When the data is linear it follows the mathematical rule as in protein, ash.

62

## Starch

### Starch – Related Quality Measurements

- Alpha amylase activity
- Starch Damage
- Partial waxy starch for udon noodles

63

## Starch Quality – Alpha Amylase

Alpha-amylase breaks down starch into fermentable sugars during fermentation in bread baking. When milling sound wheat, the level of alpha amylase is low, therefore, many millers supplement fungal alpha amylase to a desired level suitable for the baking process used.
Malt flour was used in the past for the same purpose, but now fungal alpha amylase is used as it has many advantages including a protection against overuse.

64

## Starch Quality – Alpha Amylase

These tests measure the alpha-amylase activity

- Falling number
- Amylograph
- RVA

65

## Alpha Amylase – Falling Number

It is primarily used to measure sprout damage in wheat and enzymatic activity in wheat flour.
The measurement is reported in time (seconds) that it takes the stirrer to fall through a flour/water slurry as it is being heated. High enzymatic activity breaks down the starch rapidly resulting in a low number. Conversely, low activity will result in higher value .
The cereal enzyme alpha-amylase is present in the wheat, especially when wheat undergoes a wet harvest. Wheat tends to sprout under such conditions. There can be high level of sprouting depending on the extent of exposure to moisture and ability of dormancy of the wheat variety to sprouting. The activity and amount of alpha-amylase can be very high under such conditions rendering very poor functionality.

66

## Alpha Amylase – Falling Number

| Wheat | Severely Sprouted, % | Total Sprouted, % |
|---|---|---|
| 1 CWRS | 0.1 | 0.5 |
| 2 CWRS | 0.2 | 1.0 |
| 3 CWRS | 0.3 | 3.0 |

Various levels of sprouting have a varying degree of impact on the functionality. It has been reported that 1 severely sprout damaged kernel could reduce the falling number by as much as 25 sec. Therefore, in establishing wheat grades the percentages of severely sprout damaged kernels are taken into account separately in addition to the total percentage of sprout damage in wheat.

Typically, FN of 300 sec is used as a min although in North America millers would go down to 250 sec in wheat for bread flour

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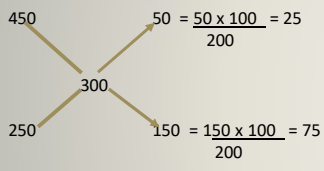
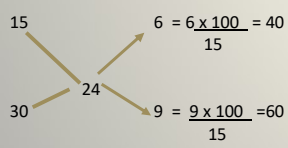
## Blending for Falling Number

Wheat 1 FN = 450 Wheat 1 LN = 15
Wheat 2 FN = 250 Wheat 2 LN = 30
Target FN = 300 Target LN = 24

alculations basis FN:




Calculations basis LN:




Often blending of sound wheat is carried out with sprouted wheat to salvage the sprouted wheat. Under such circumstances the FN of wheat being blended are converted to liquefaction number (LN). These values are then used to meet the targeted LN value for calculation of the blending proportion. Blending on the basis of FN will provide inaccurate results as FN values are not linear.

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## Alpha Amylase - Amylograph

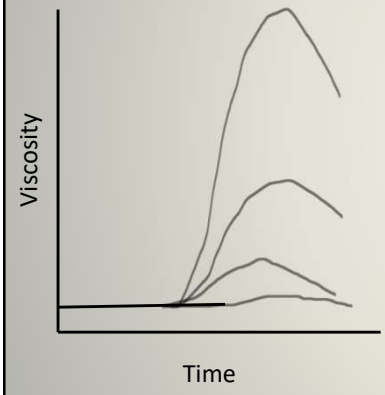
| Wheat | Falling Number, sec | Amylograph l Peak Viscosity, BU |
|---|---|---|
| Hard Wheat A | 309 | 375 |
| Hard Wheat B | 378 | 279 |
| Hard Wheat C | 279 | 121 |

Amylograph measures the viscosity of a flour and water suspension at an increasing rate of $1.5^0$C per minute from $30^0$C to $95^0$C. As the temperature increases the starch begins to gelatinize increasing the viscosity. Depending on the alpha-amylase activity present the starch is broken down reducing the viscosity. The peak viscosity that is reached will be dependent on the level of enzymatic activity present.

Even though a minimum of 300 FN is considered a good standard, but sometimes Amylograph peak viscosity may show a poor corresponding quality.

69

## Amylograph Curves – Optimal Viscosity




Amylograph measures the amylase activity and gelling properties of starch in a more comprehensive manner. It provides an indication of how starch will behave during baking. Although here we are using a starch and water slurry which thickens as heat is applied to it versus baking of a dough, but some assessment is derived. Protein releases water during baking which must be absorbed before the dough becomes runny. The optimal alpha amylase level will help binding the water. Any deviation will result in inferior quality either way.

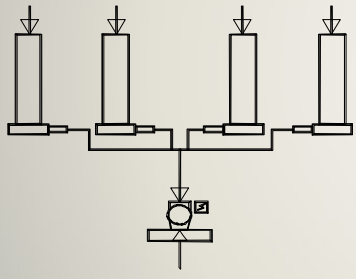
70

## Controlling Supplementation of Alpha Amylase

71

ADA Alpha Fungal Alpha Benzoyl Peroxide Enrichment

**Micro Ingredient Bins**



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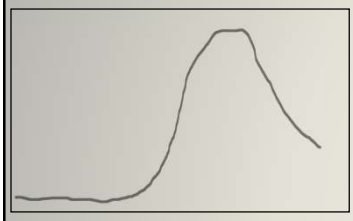
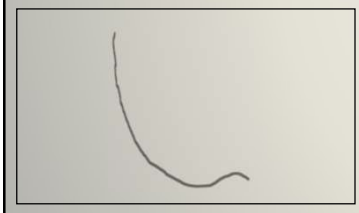
## Methods for FAA Determination



Amylograph - Malt



Modified Amylograph - Fungal Alpha

- Modified Amylograph
- Modified Falling Number

73

## Blending for Amylograph Peak Viscosity

Flour 1 = 560 = 1/560 = 0.001786
Flour 2 = 950 = 1/950 = 0.001053
Target Blend = 640 1/640 = 0.001563

Calculations basis FN:

$$0.001786 \qquad 0.00051 = \frac{0.00051 \times 100}{(0.00051 + 0.000223)} = 69.5528$$

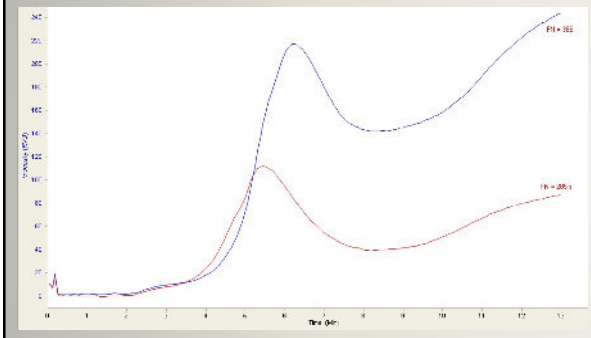
0.001563

$$0.001053 \qquad 0.000223 = \frac{0.000223 \times 100}{(0.00051 + 0.000223)} = 30.44872$$

When blending of flour is required with respect to a target Peak Viscosity value then the peak viscosities need to be divided into 1 to convert to linear values and then blend calculations could be performed to obtain more accurate blending proportions.

74

## RVA – Pasting curve for high and low falling number wheat flour



RVA is used for measuring pasting properties of wheat and other starch containing flour under heating and cooling cycles. This capability is recognized as very useful in evaluating various quality aspects of starch containing food. In addition to measuring enzymatic activity, such as, sprout damage in wheat, it provides comprehensive pasting, and gelatinization property evaluation. It can also be used for assessing other functional use such as assessment of fungal alpha amylase, starch damage and water holding capacity. It is widely used as a research tool.

75

## Starch Quality – Starch Damage

In milling starch granules get damaged during the grinding process. The appropriate level of damaged starch is very important in bread making process. Too much of damaged starch will cause inferior baking results with sticky crumb and potentially higher level of gas production than required, especially in baking processes involving longer fermentation.

Even at low temperatures damaged starch is susceptible to enzyme attack and as temperature rises and rest of the starch is gelatinized it becomes available to enzyme attack.

76

## Starch Quality – Starch Damage

| Passage | Starch Damage, % |
|---|---|
| B1+B2 | 3.8 |
| B4 | 4.4 |
| 3M | 8.5 |
| LG | 9.3 |
| SG | 5.4 |

Starch damage is inflicted more easily when :

- Harder kernel textured wheat is being milled
- Grinding hard on smooth reduction rolls with good matt finish
- Corrugated grinding passages produce lower starch damage

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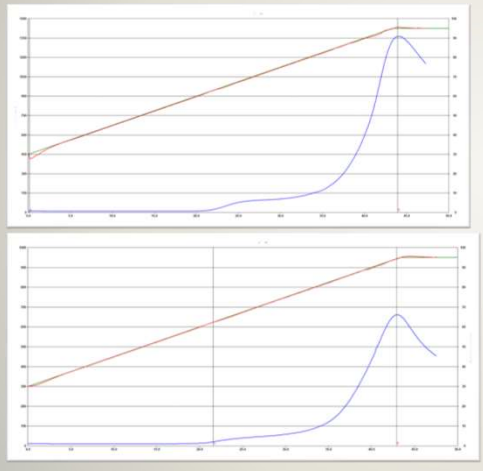
## Starch Quality - Partial waxy starch



There are wheat types that have lower than normal levels of amylose. These wheat are referred to as partial waxy . Flours from these wheat are preferred for certain Asian products for specific textural requirements, sch as, udon noodles.

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## Influence of Milling on End-Product Quality

- Influence of flour extraction rate on flour functionality impacting end-product quality
- Influence of flour stream selection and divide
- Influence of Fine Grinding on flour Functionality
  - such as, ”00” Flour for Pizza, Pasta & various applications giving distinctive flavor and texture referred everywhere
  - Finely ground white whole grain flour, such as, Ultra grain Flour
- Influence of flour improvers

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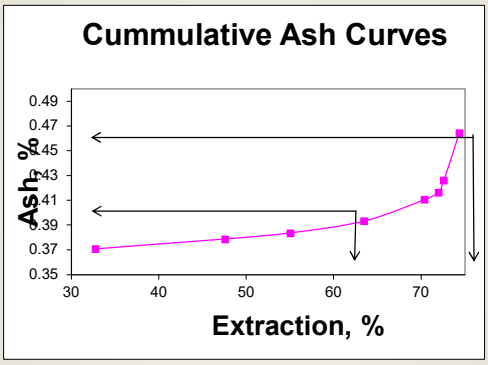
## Flour Extraction – Quality data




80

## Flour Extraction – Impact on Quality

| Flour Type | Short Patent | Medium Patent | Lower Grade | Straight Grade |
|---|---|---|---|---|
| Protein, % | 13.1 | 13.7 | 15.7 | 14.3 |
| Wet Gluten, % | 37.1 | 39.3 | 43.0 | 40.5 |
| Ash , % | 0.36 | 0.39 | 0.63 | 0.51 |
| Minolta Colour – L* | 87.5 | 86.7 | 84.0 | 85.2 |
| Amylo. Peak Viscosity, BU | 850 | 830 | 630 | 640 |

As flour extraction increases protein, wet gluten and ash content increase. The colour values showing brightness and Amylograph peak values go down. The column showing straight grade is made up of all the three columns on the left.

81

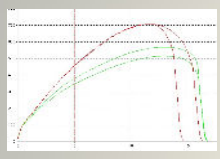
## Flour Extraction Influences Farinograph Results

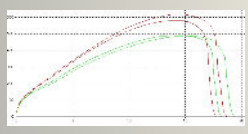
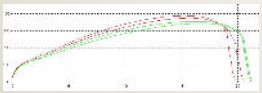
| Flour Type | Short Patent | Medium Patent | Lower Grade | Straight Grade |
|---|---|---|---|---|
| Water absorption, % | 69.0 | 69.6 | 71.1 | 70.2 |
| Development time, min | 13.5 | 8.3 | 6.5 | 6.7 |
| Stability, min | 26.4 | 24.2 | 8.9 | 9.1 |
| MTI, BU | 3.00 | 8.00 | 23.00 | 27.00 |

The water absorption increases with the flour extraction rate while the dough strength as expressed by dough development time, stability and mixing tolerance index goes down .

82

## Flour Extraction Influences Extensograph Results



The Extensograph curves show reduction in dough strength as flour extraction increase. This means the resistance goes down and extensibility increases.

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## Flour Stream Quality Data for Medium Hard Wheat

| Flour | Moisture | Ash | Starch Damage |
|---|---|---|---|
| 1 & 2 BK | 14.8 | 0.58 | 3.8 |
| 3 BK | 14.4 | 0.66 | 3.8 |
| 1 M | 13.5 | 0.37 | 3.8 |
| 2 M | 13.4 | 0.44 | 4.1 |
| 3 M | 12.6 | 0.39 | 8.5 |
| 2 Q | 13.7 | 0.52 | 6.1 |
| 4 M | 11.6 | 0.56 | 11.6 |
| 5 M | 12.9 | 0.62 | 5.7 |
| L G | 11.4 | 0.95 | 9.3 |
| T | 12.6 | 0.77 | 6.1 |
| 4 BK | 13.6 | 0.93 | 4.4 |
| Straight Grade | 13.1 | 0.53 | 5.4 |

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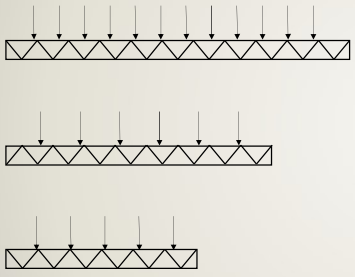
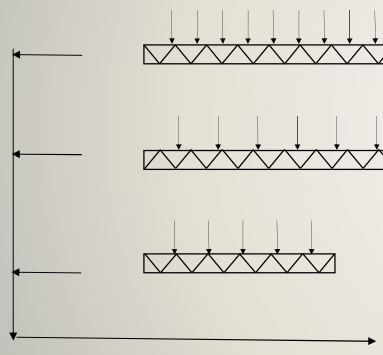
## Influence of Milling on End-Product Quality



| | |
|---|---|
| Top grade | 43,4% |
| Middle grade | 29% |
| Low grade | 6,5% |

85

## Influence of Milling on End-Product Quality



| | |
|---|---|
| Top grade | 43.4% |
| Middle grade | 29% |
| Low grade | 6.5% |
| Straight Grade Flour | 78.5% |

86

## Processing various grades of flour

Straight Grade Flour 78.5%

Too Elastic ↑ ↓ Too Extensible

Long Patent Flour 72%

Straight grade flour produced is usually used for many applications, especially, for bread baking. If the flour is slightly weaker , such as, lower mixing and/or fermentation tolerance , some low-grade flour streams could be taken out to improve the quality. If the flour is too extensible for other applications same approach could be taken. For example, pizza flour

87

## Processing various grades of flour

| Flour grades | Production, % | Application |
|---|---|---|
| Top patent | 20% | General purpose |
| Strong bakers | 52.4% | Hearth breads |
| Large bakers | ~75% | Pan breads |

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## Flour Extraction Influences End Use Quality (Baked Goods)

- Color
- Fermentation tolerance
- Mixing tolerance

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## Flour Extraction Influences End Use Quality (Noodle Products)

- Color
- Color stability
- Texture
- Cooking properties

90

## Influence of Milling on End-Product Quality

- Influence of Fine Grinding on flour Functionality
  - such as, ”00” Flour for Pizza, Pasta & various applications giving desirable flavor and texture that are widely popular
  - Finely ground white whole grain flour, such as, Ultra grain Flour with improved functionality, and sensory attributes

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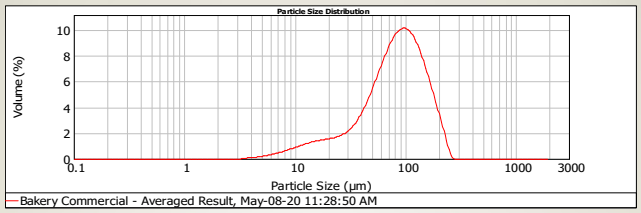
## Particle Size Distribution

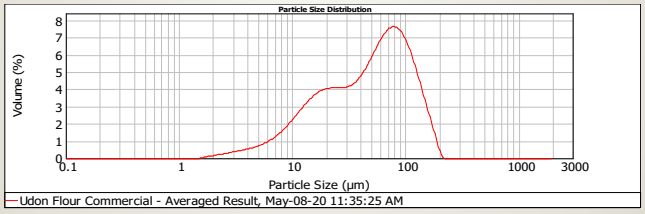
- Measurement of PSD

92

# Flour particle size




A sample of a Commercial bakery flour in Canada




A sample of Udon flour from North Asia

Source: Milling flour for Asian Products, A. Sarkar, CFW

93

# Flour particle size

| Particle size distribution | | | | |
|---|---|---|---|---|
| **Flour samples[b]** | **d(0.1), µm** | **d(0.5), µm** | **d(0.9), µm** | **D[4,3], µm** |
| Bakery flour | 23.6 | 82.4 | 161.4 | 88.9 |
| Udon | 11.0 | 49.7 | 120.1 | 58.1 |

[a] Malvern Mastersizer 2000 (Malvern Instruments Inc.).

[b] Bakery flour sample from North America and Udon flour sample from North Asia

Source: Milling flour for Asian Products, A. Sarkar, CFW

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## Selection of Flour Streams

Flour with balanced dough properties will allow for extensibility in the dough while maintaining enough elasticity. Elasticity is at times gets confused with extensibility. Doughs associated with high elasticity may be perceived as having a stretchy dough whereas extensibility is required for such property. More elasticity the dough has the tighter dough becomes. That works up to a point for ensuring finished bread products hold their shape during final proofing. On the other hand, too much extensibility and not enough elasticity will result in poor bread quality. We need good extensibility with sufficient elasticity to allow for nice volume.

95

## Selection of Flour Streams

What should be the optimum balance between the elasticity and extensibility will depend on each product type defining the texture character of the crust and crumb structure. For example, bagels require toughness, chewy texture, and tight crumb structure requiring high protein and strong gluten. On the other hand, too high a protein and strong gluten properties would result in more crusty texture in croissant. It also will make it difficult to process croissant in terms of rolling out as there will be a spring back tendency. Similar differences will apply for thick and thin crust pizza. In case of cookies and cake production it will be even more different.

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# End Products

Flour Functional Properties & Specifications

97

## Asian Products

Wheat selection & process adjustments – Specific to end use quality requirements

The following points in general are observed for production of flour for all Asian products

- Low overall specks with minimal presence of dark specks is very critical
- Good colour stability is very important, as enzymes responsible for discolouration are more concentrated in outer layers, therefore it is imperative to extract endosperm from wheat kernels carefully leaving contamination with the outer layers as minimum as possible
- Fine flour particles help in quick hydration and gluten development therefore it is a general preference for all Asian products
- Balanced gluten properties are required for all Asian products for processing requirements and textural attributes
- Protein content requirement is end product dependent
- Partial waxy starch properties are preferred for specific end products , such as, Udon noodles

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## Asian Products – Dumpling Flour

| | Dumpling |
|---|---|
| Protein, %: | 11.0 +/- 0.5 |
| Ash, % | 0.4 +/- 0.3 |
| Color | Bright or creamy white |
| Gluten strength | Balanced dough properties |
| Pasting properties | Good |
| Particle Size | Fine with low starch damage |

Wheat quality and milling process applied, have impact on the quality of flour. Flour with low ash and bright color with minimal of specks is critical. Sound wheat with medium protein content and gluten strength should provide the desired balanced dough properties such that the dough is extensible enough during sheeting without springing back but not too strong to cause stress and tear. Good pasting properties with soft elastic texture provides desirable sensory attributes.

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## Western-Style Products – Bread Baking

### Bread Quality

- Gas Production
- Gas Retention

There are many different types of baking processes and many versions of these are used by bakeries around the world. The baking processes in North America can be categorized into the following main four processes:

- No-Time Dough
- Straight Dough
- Sponge & Dough
- Liquid Sponge/Brew

Regardless of the process used baking quality is determined by gas production and gas retention. These two factors have to be in balance to achieve good results.

100

## Bakers' Flour for variety of bread and rolls

| | Large bakers | Strong Bakers |
|---|---|---|
| Protein, %: | 12.6 +/- 0.3 | 13.7 +/- 0.3 |
| Ash, % | 0.52 +/- 0.3 | 0.55 +/- 0.2 |
| Min. Viscosity, bu | 250 +/- 40 | 220 +/- 20 |
| Farino Stability, min: | 10 – 12 | ~15 |

Large bakers and strong bakers flour are milled from hard red spring wheat. Large bakers is a straight run flour grade. Sometimes a portion of low-grade flour streams are removed. Strong bakers' flour is produced selecting flour streams to prepare a high protein high gluten strength flour.

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## Pizza Flour Quality – Thick Crust

Typically, pizza flour can be broadly categorized into two categories - thin and thick crust. The protein content in the flour for thick crust is usually around 12.0% +/- 0.5%. This allows adequate protein to form a continuous protein (gluten) network for sheeting. This allows a chewy texture without the toughness. Due to thicker bread type form a more fermentation action preferred for slightly enhanced volume. This is achieved through formulation (more water, yeast and sugar).

Milling Specifications: Protein 12.0% +/- 0.5%, Medium strength flour, Long patent lower ash flour

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## Pizza Flour Quality

Thin crust pizza requires a higher protein flour for a crispy, thin crust. A Protein content range of ~12.5% to 14.0% is commonly used milling hard wheat flour. A protein content of 14% may be used for a crispier texture. Often l-cysteine hydrochloride is used to provide a good extensibility maintaining the strength to hold it together during stretching. This also helps in the uniformity of the crust following stretching. Essentially, less time is spent in handling, stretching and rolling. If the dough is tough or shrinks the addition rate is increased and conversely it is reduced.

Milling Specifications: Protein 13.0% +/- 0.5%, Strong gluten strength flour, Long patent, lower ash flour. Often treated with l-Cysteine to improve stretching

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## Croissant

Medium gluten strength with protein content of about 11.5% +/- 0.5% works well. Such specifications can be obtained by using a medium strength wheat of appropriate protein content or it can also be obtained by blending hard and soft wheat to obtain the required flour specifications. Good balanced dough properties are very important. Good extensibility helps in easier rolling out and in holding its shape while elasticity helps in the volume that is needed for it to be light and airy. Too high a protein will have a firmer, slightly thicker crust and may be difficult in rolling. Too much pressure or too much rolling will melt the butter absorbing in the dough.

Milling Specifications: Protein 11.5% +/- 0.5%, Medium strength flour.
Alveograph W value of ~300 and P/L of 0.5-0.7

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## English muffins

High protein content flour of 12.5%+/-0.5% is preferred, milled from a wheat or wheat blend of high gluten strength. This is required for high water absorption (85% of the formula) and to maintain good gas retention in the proofer and the griddle. High water absorption helps in leavening and contributes to porous crumb structure. High protein helps in maintaining the required chewy texture in the muffin. In case of making up for lower protein vital gluten can be supplemented.

Milling Specifications: Protein 12.5% +/- 0.5%, Strong gluten strength, straight-run flour is required for high water absorption and good gas retention . High protein helps chewy texture. Vital gluten is added to make up for any deficit in flour protein.

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## Bagels

Bagel's characteristic chewy texture, tight and fine crumb with glossy, leathery crust makes them uniquely different from other bread types. Flour for bagels require high protein (>/=14.0%) and high gluten strength often requiring oxidation of flours for the desired texture characterized in the end-product. Higher protein improves the quality of bagel in terms of specific-volume and symmetry of the bagel. If there is not adequate protein in the flour, it can be compensated for by adding vital gluten. Bagels produced from lower protein flour will result in tender and open crumb end-product.

Milling Specifications: High protein >/=14.0%, strong gluten strength flour, Often treated with oxidizing agents. Lower protein can be supplemented with vital gluten

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